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Forthcoming Events.

JANUARY 9.

Institute of Metals (Sheffield Local Section):—Ordinary meeting at Sheffield. "Die Casting," Paper by A. H. Mundey.

North-East Coast Institution of Engineers and Shipbuilders:—Ordinary meeting at Newcastle-on-Tyne. "Theory of Longitudinal Bending of Ships," Paper by J. Lockwood-Taylor.

Barrow and District Association of Engineers:—Ordinary meeting. "Research on the Flow of Gases to Establish Principles for the Scientific Construction of Furnaces," Paper by T. Hopkins.

Institution of Mechanical Engineers:—Ordinary meeting in London. "The Maintenance of High-compression Oil Engines."

Institute of Metals (Birmingham Local Section):—Ordinary meeting, at Birmingham. "Cobalt, its Production and Some of its Uses," Paper by T. H. Grant.

JANUARY 10.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "The Making of Thin Section Patterns for Stoves, Grates, etc., from the Plaster to the Finished Pattern Plate," Paper by T. W. Markland.

Institute of Metals (London Local Section):—Ordinary meeting in London. "Extensometers," Paper by R. H. Greaves, D.Sc., F.I.C.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

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The Amorphous Foundry Industry.

Sir Charles T. Ruthen, H.M. Director-General of Housing, writing in the "Industrial Supplement to the Sheffield Daily Telegraph," estimates that no less than 1,360,000 tons of pig-iron is used annually for foundry purposes, and that 150,000 tons are used for light (that is builders') castings. It is not clear whether Sir Charles means that this quantity is used in the iron foundry, but in any case it is no exaggeration to say that more than 2,000,000 tons of iron castings are made each year. This would indicate that the average production of each foundry is of the order of 13 tons a week, which seems reasonable enough.

It thus becomes easy to calculate the consumption of scrap, coke, limestone, sand, bricks, coal dust, and other raw materials, whilst the enormous potentialities for installation of machinery and the consumption of such materials as core oils can readily be visualised, especially when taking into consideration that neither steel nor non-ferrous castings are included.

Yet the industry has no identity in the Board of Trade Returns. It has neither a national employers' federation nor a national trade union. The only time it ever came prominently before the eyes of the public was some five years ago during the English moulders' strike, when the symptoms of creeping paralysis were being translated into reality.

Much has been said about key industries during and since the war, but, closely examined, the foundry trade is the key of key industries. Nothing is consumed on a large scale which does not incur the use of cast iron. It is the very basis of modern civilisation, but it is still unrecognised by the people who matter. The industry is best understood by the mechanical engineer, but generally speaking, he regards it in a very distorted way. Often the engineer's buyer congratulates himself that he has bought castings below an economic price. Of course, it helps his firm either to secure more business or to make larger profits. But he is driving a key industry, if not exactly into liquidation, at least into a position where it cannot afford to modernise itself as it should, the benefit of which he himself would ultimately derive. Other buyers constantly turn their attention to the Continent, especially for the supply of light steel castings, and it would be interesting to learn the true extent of this business, for we cannot reconcile the Board of Trade figures with the amount of damage done to this important section of British industry. From memory we can recite over a dozen plants manufacturing steel castings which have ceased to function since the war. There are about 120 steel foundries in Great Britain, which, of course, includes the largest in the world, and many other extremely important concerns, but at the same time, the elimination of even a dozen small plants is to be regretted. We ascribe their failure more to their inability to cost and properly to utilise the figures obtained than to bad trade.

An industry which makes 2,000,000 tons of cast-iron castings a year should be capable of assuring for itself a much larger voice in the conduct of its business than it does at present. It should be in position to know the weight and value of its imports and exports, and of how they are constituted. Most countries show the figures for cast-iron pipe and iron castings, but they do not disclose the amounts of builders', automobile, electrical, agricultural and municipal castings. In the British Board of Trade Returns there is generally a considerable importation under the classifi-

cation "electrical fittings." It would be interesting for foundrymen to know what percentage of this figure relates to American malleable cast-iron castings. So far as these returns are concerned, castings loose their identity the minute another classification can be found. Maybe the golden rule with the officials is to place in the category of "castings" only that material for which a "better" classification, such as "hardware" or "electrical fittings," cannot be found.

It is desirable for any industry to know the extent of its foreign competition and business, but as a concrete industrial entity the foundry does not as yet exist.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The New Salesmanship.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The admirable series of articles on "The Selling of Castings" makes me contrast sharply the methods employed by a few of the Foundry Equipment supply people, which are sometimes quite humorous regarded from a purely British standpoint. For what follows, however, I offer suitable apologies to its most active exponents on both sides of the Atlantic.

Like many another man in the foundry trade, I have always been accustomed to innovations which are going to cut foundry costs to *nil*, double the output, eliminate the fuel bill, and relegate all repair bills and replacements to a succeeding generation—but I know the language of inventors, and have obtained many a useful idea from them. During the last few years, however, there has been elaborated a new method of approach, and the average supplier now employs an idiom which is occasionally as aggressive as it is extraordinary. I find that I am now regularly addressed upon the following lines:—

MR. FOUNDRYMAN,—

You can save your time and save your money by letting us quote you for everything for the foundry. Are you able to meet competition, or is your equipment as old-fashioned as your maiden aunt Jane's furniture back in the home town? If your business is sick, it needs a tonic which we can give. Just give us the data of what you are doing, and we will show you how to do it better, quicker, and cheaper.

Our Firebrick Expert complains that the foundry trade has not been keeping him as fully employed with conundrums as usual during the past few weeks. Just fire in your own, and let it be a teaser!

Our Core-gum man drops me a hint not to forget to tell you that he has got something entirely new up his sleeve which is to help you in the New Year; but a full description of this must wait for our next issue.

To the 5,000 friends who have written us during the past five weeks we give hearty thanks and requests for more and more of their letters and inquiries. Don't forget that we have experts on everything from a cupola to a chaplet, all of them brimming over with enthusiasm and service.

Very cordially yours,

XX Co.

Sometime or other I shall be tempted to reply. One bad morning, on top of a poor breakfast, a lost contract, and an extra number of scrap castings, I shall seize my fountain pen and deliver a counter-attack upon the enemy, employing his own tactics.

MR. JOBBER,—

Guess you must excuse me if I address you in this bright and breezy way—seems like it's getting the foundry manner.

About my foundry, it's sure right out of date, as I haven't got any of your products, but I'm not quitting yet. I'm tickled to death that the brick expert isn't busy, so here's one for him: How long does he figure my firebrick lining lasts at a regular 30 tons per week, when it's not supplied by him?

Sorry I am not taking any of your lines, but as I've been in the foundry trade for twenty years I calculate I know where to get supplies, and unless the cuts in your bulletin are meant to pull the wool over my eyes I figure that I get most all of them from the same place as you.

Say, your copywriter is some go-getter, but tell him from me that if he wants to get his quota from this territory, he'll have to quit reading those salesmanship books, and try talking the language of the prospect for a change. His style gets my goat worse than the captions in the movies. Oh, boy, it's sure dead easy, but it doesn't cut much ice.

Sincerely,

A FOUNDRYMAN.

The only question is: Will he cease from troubling me after that, or (horrid doubt!) will he come down, and by the efficient salesmanship, of which I have heard so much, sell me a couple of cupolas, a few moulding machines, and an entire new foundry plant in revenge!

Yours, etc.,

"QUIZ."

Vanadium in Foundry Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Owing to the fact that I have only just returned from a three months' absence in the United States, I have seen for the first time the foundry query of your correspondent, "H. S.", published by you in your issue of October 23, 1924.

Your correspondent would make a great mistake, both from a utility and a cost point of view, in adding so large a quantity as 1 per cent. of vanadium to foundry iron. One-fifth of 1 per cent. (0.20 per cent.) is the maximum amount which he need add to well-melted clean foundry iron in order to attain abnormally good results from it. But I must point out that in my opinion he should most certainly use "carbonless" ferro-vanadium, preferably in the form of a crushed alloy containing about 35 per cent. of vanadium, 2 or 3 per cent. of silicon, and a per cent. or two of aluminium; in other words, when adding 0.20 per cent. of vanadium he should add just under 0.6 per cent. of *such alloy*.

The description "carbonless" must be interpreted inferentially rather than literally; by it is understood by the technologist an alloy which has been reduced and smelted by means of a reagent other than carbon. I strongly recommend him on no account to use for treating cast iron a vanadium alloy which is the product of electric furnace smelting, not because the small percentage of carbon will interfere appreciably with his analytical balance, but because of the relative insolubility in molten *cast iron*, which, from reasons of non-dissociation, may be the attribute of the electric alloy.

Ready solubility and complete miscibility are absolute necessities in the successful vanadising of cast iron in the foundry.

I feel that I cannot do better than refer your correspondent to my article in your Journal of July 19, 1923, where methods of application and detailed results are dealt with at some considerable length.

When reading this he should also look up a following issue, wherein I endeavoured to deal, in the form of a letter, with the editorial comments regarding porosity.—Yours, etc.,

J. KENT SMITH.

1, Staniforth Road, Sheffield.
December 31, 1924.

Cupola Men Commended.

The bravery of Edward Restall, Clarence Chance, and Walter King, three foundrymen of the Midland Carriage and Wagon Company, Washwood Heath, who made heroic attempts to save the life of Walter Langley (48), of 85, Inkerman Street, Vauxhall, who fell into a cupola while at work on December 10, was commended by the Birmingham City Coroner (Mr. Isaac Bradley). At the adjourned inquest a verdict of "Accidental death" was returned, the Coroner adding that he would be pleased to give his name to any letter of recommendation that may be sent to the Carnegie Fund or the Royal Humane Society.

Institute of British Foundrymen.

Presidential Address to Sheffield Branch.

By PROF. CECIL H. DESCH, F.R.S.

The Improvement of Cast Iron.

It is encouraging to notice that the metallurgy of cast iron, a subject which has been strangely neglected, is now receiving a greater meed of attention, although its position is still low in comparison with that of other branches of metallurgy. Research into the properties of cast iron is particularly active in Germany, and it is from that country that we hear of the most interesting innovations, although America shows much activity, on less scientific lines. It must be admitted that few opportunities have been provided for scientific instruction in the principles of foundry practice, and that the subject has been unduly neglected by teachers and by students. Steps are now being taken to remedy this evil, and progress has been made, in spite of certain grave difficulties inherent in the nature of the foundry industry. An inquiry by the Board of Education, in which the speaker was privileged to take part, revealed some of the difficulties in the way of providing technical instruction for apprentices in foundries, but also proved that in some of the most important foundry centres there is a real desire to afford facilities for such instruction. A report on the problem has been issued by the Board, containing suggestions as to the courses to be established and the measures to be adopted in order to provide training for apprentices, so that foundry workers may have the means of obtaining instruction similar to those possessed by fitters, patternmakers and others. Sheffield did not wait for these recommendations, but decided to act immediately, thus presenting an example to other centres. A committee on which foundry employers, trade union officials, welfare workers, the local Education Committee, the University, and the technical societies, including her own, were represented, sat for some time to consider the possibilities of establishing systematic training courses, and especally of overcoming the known reluctance of the foundry apprentice to attend the usual evening classes in technical subjects. As the result of the sittings of this committee a scheme has been adopted, leading up to a Foundry Trades Technical Certificate, to be gained by those who have successfully passed through a systematic course of instruction. The scheme, details of which may be had, provides for two years' work in an evening continuation school, beginning when the boy enters on his apprenticeship, and intended to improve his general education. This is followed by two years in a central evening school, where training in chemistry, mechanical drawing, and other subjects bearing on the work in the foundry is given. The last three years are occupied by evening instruction in the principles of foundry work, given in the Metallurgical Department of the University of Sheffield, success in which will be recognised by the award of the certificate mentioned above. It is hoped that this scheme, which has already been put in operation, will result in the provision, in the course of the next few years, of a supply of adequately trained foundry workers. Steps have been taken to provide technical instruction for men already employed in the industry, but too old to begin at the beginning of the course here outlined.

Pearlitic Cast Iron.

Turning to the problems which interest our skilled foundrymen and managers, we may consider the question of improving the quality of cast iron, and so further increasing its usefulness as an engineering material. Looked at from the point of view of the scientific metallurgist, cast iron is essentially a variety of steel, having its continuity interrupted by flakes of graphite and by patches of the hard phosphide. These constituents may be regarded as foreign inclusions, weakening the metal, although the phosphide, by its hardness, exerts a favourable influence for some purposes. The graphite is present because the carbon lowers the melting point of iron, and makes it possible to melt and cast at a temperature far below that required for steel, thus furnishing a cheaper and more convenient material. Moreover, the expansion which occurs, not during solidification but immediately afterwards, due to the liberation of graphite from the decomposing carbide, enables the metal to take a sharp impression of the mould instead of shrinking away from it. Evidently, the strength and toughness of the iron are properties of the matrix, that is of the steel in which the graphite is embedded. Attempts to improve cast iron have therefore to provide for the formation of a matrix of maximum strength and toughness, and for the minimum interruption of that matrix by graphite plates. In other words, neglecting the phosphide for the present, the best cast iron is likely to consist of a strong steel, containing graphite crystals of such small size and so grouped as to produce the least weakening effect. The toughest steel has the composition of pearlite, containing 0.89 per cent. of carbon. There has recently been much talk of "pearlitic cast iron," a product of such composition, and cast under such conditions, as to consist when cold of a mass of pearlite broken only by groups of small crystals of graphite. How far the process of manufacture is novel is a matter for experts. It is, however, worth mentioning that within the speaker's knowledge excellent small castings were made in quantity during the war by casting a suitable iron in red-hot iron moulds, ejecting immediately the metal was solid, and turning out into a mass of smouldering sawdust for slow cooling. The iron so produced was wonderfully soft to machine, and had excellent mechanical properties. A recent paper by Emmel, of the August-Thyssen-Hütte, gives the following figures as representing suitable compositions for pearlitic cast iron, if cast under proper conditions.

	Total C.	Graphite.	Comb C.	Si.	Mn.	P.	S.
1	3.46	2.54	0.92	1.08	0.96	0.40	0.090
2	3.48	2.66	0.82	0.98	1.02	0.32	0.088
3	3.32	2.35	0.97	1.10	0.62	0.47	0.137
4	3.20	2.14	1.06	1.14	0.70	0.48	0.155

The combined carbon in the irons shown in the table is always near to the composition of pearlite. Another series of irons is mentioned by the same author, containing 1.5-1.9 per cent. of silicon and only 0.03 per cent. of sulphur, this proportion being lower than can be obtained in the cupola, so that an oil furnace has to be used. The high silicon, which however must not exceed 1.9, makes it possible to machine the iron without heat treatment.

If a product of this kind is to be obtained with regularity, so that its uniformity approaches that of steel, it will probably be necessary to introduce improved methods of melting. The cupola, useful though it is, is a comparatively crude appliance, and oil-fired furnaces have to be considered. Improvements in the cupola have also been attempted, and some of these we may hear further during the present session. Another direction in which improvement is to be looked for is in the manufacture of permanent moulds. Iron moulds have their disadvantages when used for long periods at high temperatures, and it will be necessary, either to improve the iron considerably, perhaps by the addition of alloying elements, or to find a satisfactory substitute. The great progress now being made in our knowledge of refractory materials may help in this direction.

There are many reasons why cast iron of close grain, with minute particles of graphite held in a pearlitic ground-mass, is desirable, apart from its strength and machining qualities. Chemical attack, such as the destruction of acid tanks by sulphuric acid, is associated with an open grain. The acid penetrates into the metal by way of the large graphite plates, and crystals of ferrous sulphate being formed in the cavities, their outward thrust disintegrates the iron. The speaker has met with striking instances of this action. Similar considerations apply to irons which are to be subjected to high temperatures and to the action of oxidising gases. It has been shown by Carpenter and others that "growth" only occurs in graphitic irons, and is particularly marked in irons containing a high proportion of silicon. The action advances along the surface of the large plates of graphite.

The scientific evidence goes to show that all cast iron is white, that is, it contains all its carbon in the combined state, when it first solidifies. Graphite is formed after solidification, by the de-

composition of the carbide. The formation of large crystals of graphite may therefore be prevented by chilling rapidly, and then decomposing the carbide by a carefully regulated heat treatment. This is the method for the manufacture of malleable castings by the blackheart process, but it need not be carried so far as complete softening. The method of centrifugal casting has been developed largely, especially in America. By this means, using hot metal, a close structure is obtained, and the relative proportions of graphite and combined carbon are adjusted by a subsequent heat treatment. The rate of cooling through the lower critical point is of importance in determining the properties of the iron.

If we are to aim at the production of cast iron of a quality superior to that obtained by ordinary methods, it will be necessary to assimilate the practice of the iron foundry to that of the steel works. Among other things, close attention to the temperature of casting is most important, and this involves the use of the pyrometer in a systematic way. It is usually stated that for the production of pearlitic cast iron a higher casting temperature than usual is required, and means of measuring that temperature must be at hand. It may be noted, also, that graphical methods of determining cupola compositions, and of representing the relation between composition of metal and rate of cooling when a given structure is required, are being increasingly used in Germany, and it would be well for foundry experts to become acquainted with such methods, which greatly facilitate accurate and uniform work.

Lastly, a reference may be made to the vexed question of the occurrence of oxygen in cast iron. In an important paper read to the 1921 conference by our late President, Mr. Shaw, this matter was reviewed, and its importance in relation to the properties of the iron was indicated. At first sight, the presence of oxide in a material containing so large a quantity of deoxidisers, such as carbon and silicon, appears to be unnatural. There is, however, some evidence that these elements may co-exist. The native iron of Ovifak, in Greenland, may be regarded as a natural steel, produced in all probability by the reduction of a basalt rich in iron by some carbonaceous substance at a depth below the surface of the earth. Benedicks examined the structure of this iron, and found, in addition to the usual constituents of a steel, a peculiar eutectic, the two constituents of which were the carbide and oxide of iron. This "oxide-pearlite," so called from its appearance, had been formed in the original mass, and was not a product of subsequent alteration. No doubt, under the conditions of reduction, a high pressure prevailed, so that the usual reaction between carbide and oxide, leading to the production of gaseous oxides of carbon, would be inhibited, and the two solids would be able to co-exist. The pressure under which ordinary cast iron is formed is close to that of the atmosphere, so that the same explanation will not hold good, but the Ovifak iron may only be an extreme instance, and an equilibrium between the two constituents may occur even under low pressures. Some support for this view is furnished by the interesting work of Carpenter on the carburisation of iron at low temperatures, in which he found that a complex product, containing both carbon and oxygen, could be produced and recognised. It is evident that this field of research calls for further exploration.

The reorganisation of the Cast Iron Research Association under the directorship of Mr. J. G. Pearce leads us to hope that systematic research into the properties of cast iron will now receive increased attention in this country. There is no lack of problems, and there is every hope that when this material has received only a small fraction of the scientific attention which has been given to steel it may be possible to improve its quality to such an extent as to enlarge very considerably its sphere of usefulness.

AFTER six months' absence, due to illness, Mr. H. G. Sommerfield, pig-iron exporter and merchant, of Charterhouse Chambers, Charterhouse Square, London, E.C.1, is again personally conducting his business.

The Campion Blast Meter.

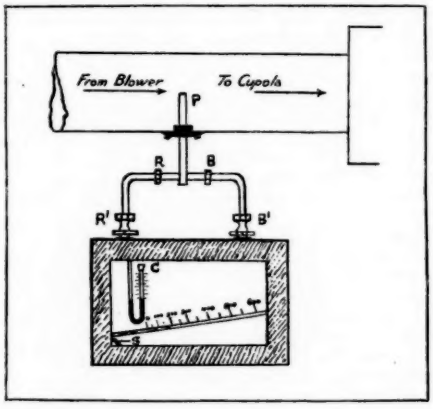
Modern industrial practice calls for more and more exact measurement and control of processes; particularly is this so in furnace or other operations involving the consumption of fuel. Foundrymen have for long employed gauges for registering the pressure of blast supplied to the cupola, but have realised that pressure alone is of little use in determining the quantity of air supplied to the furnace.

The extent of the heat produced and distributed within the furnace depends very largely upon the amount of the air supply; but hitherto there have been few instruments available for use in the foundry, and even then the cost has been high.

The instrument consists of a Pitot tube of special design installed in the air main and connected to the pressure and volume indicator, as shown in the sketch. The volume indicator is a gauge of the inclined tube type of special construction whereby great steadiness and ease of reading is secured. It is calibrated to read directly in cubic feet of air delivered per hour. The pressure gauge of the mercury type is graduated in ounces per square inch and inches.

The whole instrument is enclosed in wood case with glass front, ensuring protection from dust and weather. Adjustments to zero are easily made, and the instrument can be installed by any mechanic in a very short time. Special stopcocks and unions are provided for connecting the leads from Pitot tube to indicator.

The apparatus is installed by placing the Pitot tube P in a part of the main where there is about 6 ft. length of straight pipe, and as far away from bends and valves as possible a hole should



be bored in the main just large enough to take the boss of the flange, and two small holes tapped to take bolts for holding down the flange.

It is very important that the Pitot tube should project the correct distance into the air main. It is sent out correctly adjusted. The arrow on the head of the tube must be set exactly parallel to the axis of the main and pointing in the direction the air is flowing. The union R will face the blower side and the union B will face the cupola side.

The indicator must be set up perfectly level in some convenient place, a level is provided for the purpose. Mercury is poured into the gauge through small cup C until it reaches the zero mark.

The red liquid is poured into the tank through the filling hole, and clean water added until it rises to the zero mark on the inclined tube. The filling hole is then firmly screwed up. If the liquid is filled a little above the zero it can be run out until the top of the meniscus is exactly opposite it by means of the small tap S provided for the purpose. The mercury gauge can then be set by means of the movable scale. The unions R and R' are connected by means of copper, iron or compo. tubing, and the unions B and B' are also connected as shown in the sketch. The taps on the instrument should be open before the blast is started.

The manufacturing and marketing has been placed by Prof. Campion in the hands of Messrs. Thomson, Skinner & Hamilton, of 137, Sauchiehall Street, Glasgow, C.2.

Some Methods of Overcoming Contraction and Sullage Troubles.

By Ecossais.

New Work.

Among the many causes responsible for the production of defective castings is the omission to provide runners or ingates of suitable design and size. In the case of plate-moulding, of course, these, when finally decided after preliminary trials on new work, remain standard owing to the gates being pattern made; and provided reasonable care in pouring, with metal suitable for the job, good castings will be continually produced. The practice of making the patterns for the ingates of wood is inadvisable, except for trial purposes, even when the pattern plate is made of wood, plaster or composition, owing to the probability of pieces being chipped off, and thus affecting the sectional area of the gate and speed of filling. With a new pattern that promises some difficulty as to the most suitable position or type of runner, and for which new moulding boxes are required, a mistake often made is the making of a quantity of these before making a trial casting. Casting difficulties may necessitate slight changes in the shape or sizes of the boxes to obtain the best results, meaning that either further expense must be incurred in replacing the first lot of boxes cast for the job, or the use of these with indifferent results, owing to inability to employ the most suitable form of runner. The difference in the results, spread over a medium quantity of the castings, may easily be sufficient to have justified the scrapping of the original boxes, even though the initial expense was high. Over-eagerness in commencing a job, before proper consideration has been given to its possibilities, and to counteract for time lost in associated departments, is often the cause of the indifferent results referred to above, and which eventually end in greater delays in the completion of an order. With dual or multiple control, the general tendency is to create an increase in the number of such occurrences.

Pulleys.

It is quite a common practice in jobbing foundries for moulders when making pulleys to locate the ingates, one or more, on the boss. It is just as common practice to have to resort to such devices as baring the boss, and taking out the core at the centre to prevent fracture of the arms (with varied success). The object, of course, is to increase the rate of cooling, and the need may be actually created by the position of the runners causing superheating of the mould round the boss thus causing the boss to be the last part to cool and contract. Or the need may be due to arms of bad design, or to too heavy a boss in relation to the rim. The quality of the metal may also contribute, hard metal meaning invariably excessive contraction, while metal may be soft and show less contraction, but at the same time be weak, so that either kind may give unsatisfactory results, the former while still in the foundry, and the latter, maybe, in actual service, or during handling prior to service.

Special metal mixtures, at slightly increased cost, may result in apparently sound pulleys, but the contraction stresses, which are the direct cause of fracture, are still existent in the casting, and may cause fracture even after machining is completed. In such a case the design may or may not be at fault, and the probability is that, if the casting was gated on the rim instead of the boss, the casting would remain sound.

In the case of comparatively large pulleys, this departure from conventional methods could easily be managed by the use of stock runner cores, the section of the runner being either round or rectangular, two small ones being preferable to one large one, of either kind, and arranged tangentially, as in Fig. 1. With small pulleys this would not be practicable, owing to the probability of breaking the rim when removing the runner. In such cases the object may be attained by the use of a block on the top edge of the rim, open to the top of box, to serve also for pouring as in plan at *A* and in elevation at *B*, in Fig. 2, where the space for the actual ingate would be ample for a 12 in. to 14 in. dia. pulley, being 2½ in. × 1/16 in., the body of the metal contained in block space during pouring ensures that the light sectioned ingate does not solidify until the mould is filled.

Although suitable for a rim up to, say, 3 in. wide, greater widths would be inclined to show a dirty patch on each side of the runner when machined, due to the drop of the metal and formation of sullage, which collects in these places.

In such cases block prints may be provided, with cores to suit, so that the metal enters the mould through a similar shaped inlet to the last example, but at the bottom of the rim, and as shown in plan at *A* and in elevation at *B*, Fig. 3. Such runners are easily removed; risers on the boss and the usual feeding and baring of the boss may be dispensed with, and sound pulleys produced, without resorting to special mixtures of iron, provided the metal is reasonably strong and suitable for machining. Where quite a large number are cast daily and alteration of design is not practicable, the saving in time of feeding and baring, and the inconvenience avoided, by cutting out this procedure, are ample repayment for the necessary amount of preparation.

Small pulleys are often gated on the arms, in which case the gate must be of light section where it adjoins the casting, to facilitate removal without fracturing the arm. In some cases pulleys have very light bosses, and comparatively heavy rims, so much so in fact that the arms will be in compression due to the rim cooling last. The effect produced may then result in fracture of the rim, or the boss may be forced out of alignment to such an extent as to condemn the pulley if the machining allowance on the edges of the rim has been stinted. Such cases are exceptions, but must be provided for when they occur and then gating on the boss is an advantage; also, baring of the rim may be necessary.

As distinct from fractured arms, caused purely by a lack of balance in the rate of cooling of the boss and rim, contraction stresses are productive of cracks, which may never mature into actual fractures, and situated at the junction of arms and rim. These cracks may be almost invisible to the naked eye or may be quite open, and are due to lack, or neglect, of knowledge of elementary principles of design; sharp angular corners being left at these points and thus providing weak spots on which the contraction of the arm concentrates. By avoiding such sharp corners and joining the arms to the rim by gradual curves, the stresses, produced by contraction of the arms, and that of the rim circumferentially, are distributed around the curves, and thus, unless excessive in amount, become latent, possibly remaining so indefinitely.

Small Castings.

The practice with all castings is, as far as possible and practicable, to have all machined faces in the bottom portion of the mould. Where this is not practicable, it may be possible to arrange for the metal to enter at a point near which there is no machining on the upper face. The reason for this is that usually sullage, as distinct from mould dirt resulting from careless workmanship, being due to pouring agitation, is generally found in the vicinity of the actual ingate.

In this connection advantage may sometimes be taken of cores situated in an unimportant part of the mould, by arranging the gate so that the cores obstruct the direct flow and thus trap and retain sullage formed, while allowing the clean metal to fill the mould. The sullage thus trapped, if excessive, can be easily found with a hand hammer, but generally it appears as an apparently greasy spot—fairly solid—and consisting of a mixture of iron and sullage, which may have no detrimental effect on the casting.

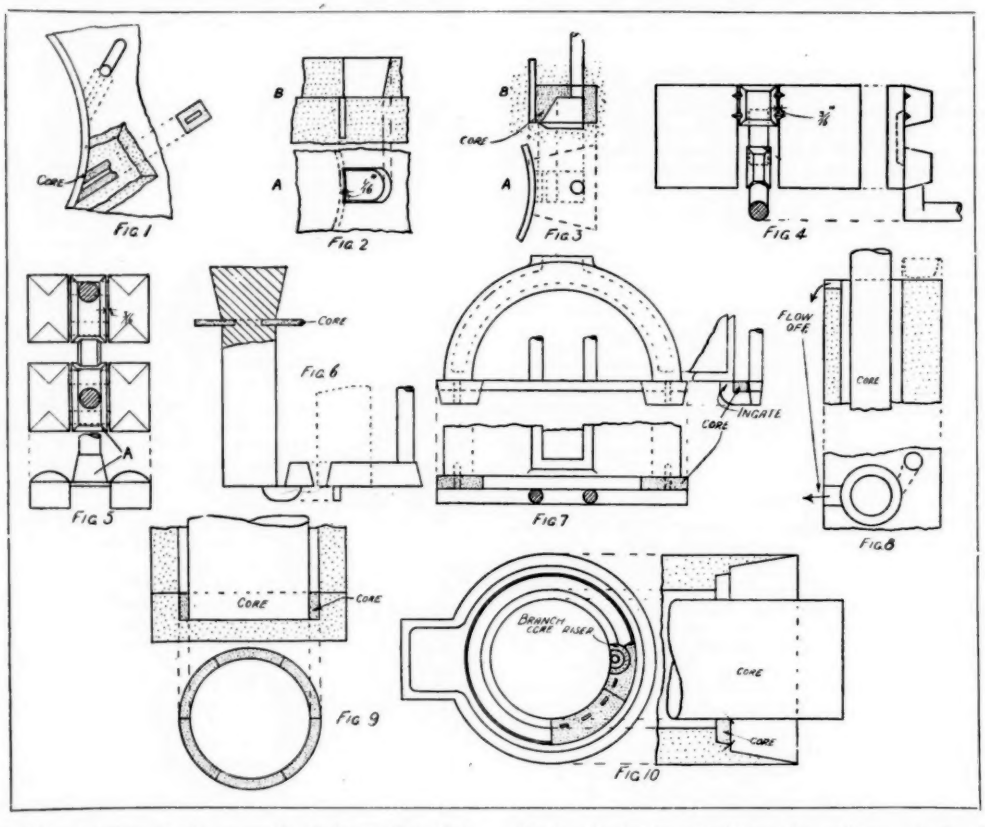
The chief aim with all small castings should be to contrive that the metal enters as quietly as

possible to avoid oxidation by exposing fresh surfaces, splashing and agitation of the metal creating more oxidation and therefore more sullage, increased by loose blacking and sand from rough parts of the mould.

Castings are frequently required to have good surfaces all round, and the results with these will differ with the moulder, from good to bad, even with a well-finished pattern leaving a perfect mould unless special attention is given to the type of runner.

Hard metal will cause more splashing than softer metal, and therefore more sullage, also damp sand and hard ramming, due to carelessness, will result in dirty castings regardless of the type of runner employed. There are quite a number of runners designed to prevent dirty castings, all more or less effective when applied correctly, and most of these have been described and illustrated in the columns of THE FOUNDRY TRADE JOURNAL.

An effective runner is shown in Fig. 4, which if correctly proportioned will practically eliminate scrap due to pouring, in the case of castings to which it is practicable to apply it. A very plain



casting is taken in the example, being a flat plate 9 in. × 6 in. × 1¼ in., to be machined all over, and of which numbers are required. Ordinary runners will cause a large proportion of scrap, even though the moulder uses every care in other respects.

In this runner the sizes of the ingates are such that if the metal is dull, and therefore unsuitable for machined work, due to the possibility of retaining slag and dirt in suspension, the castings are very liable to be short run, thus compelling the moulder to pour with suitably hot metal.

Size being therefore important, the better way is to mount the runner along with the patterns on a plate, because a runner cut out of the sand is rough-faced, and great variation in size is apt to occur, giving irregular results.

The sectional area of the down runner should exceed the total area of the ingates by about 25 per cent., the sectional area of the connecting channel in bottom part of mould being about the mean of the above. In this way the flow of the metal is checked, a small quantity of metal fills the channel, providing a trap against slag or dirt entering the actual ingates and the proportions given ensuring that this channel and the ingates are bottom fed with clean metal, which fills the mould steadily with a minimum of agitation. Usually when making trap-gates a core is used as later described in Fig. 7, but by above method the necessity for a large number of cores is avoided.

The same type of runner may be employed on small lumpy castings liable to draw, and with which feeding is not practicable. Fig. 5 shows this method applied to some blocks about 5 in. × 3 in. × 2½ in., and as cleanliness is not important the trap-gate is omitted. The block *A* must be of a section that will not solidify quickly, and on removing the castings from the box the draw shown by the top of the block *A* will indicate the efficiency of the feeding, its close proximity to the castings ensuring fluidity in the ingates until solidification of the castings is practically complete. Where a casting, of relatively greater depth than either of these preceding examples, is desired to be clean, as for instance a square block 4 in. × 4 in. × 12 in. deep, a slight variation may be adopted by forming a joint at the bottom and arranging a block and ingate as shown in Fig. 6, and thus confining the effect of splashing to the down runner and block, the latter retaining the sullage. As in the first type shown, after the ingate has once been filled, ladle dirt may purposely be poured down the runner and will float to the top of the block without entering the casting.

It is advisable to connect the down-runner to one end or side of the block, in preference to entering on the top, as the latter course might result in some dirt being forced right into the mould itself. In this type of casting, feeding will, of course, be necessary, but will be assisted substantially making up the riser as shown and, as soon as the metal appears therein, filling it up with hot metal direct from the shank or ladle.

Medium Castings.

With larger castings up to several hundredweights, similar principles may be observed when warranted by castings requiring a good upper surface. Owing to the presence of the cope bars it becomes necessary to have the whole of the runner in the bottom of the mould, using a special block and core to form the channel acting as a trap.

Fig. 7 shows a runner, for which an iron pattern was made, giving satisfactory results on castings about 7 cwts. each, using two down-runners. Modi-

fications of this can easily be made to suit any particular job, the one shown being for a casting the whole of which was in the top box. Three or four trap blocks may be used, and down-runners to suit the job according to the quantity of metal and the necessity for filling quickly.

Cylindrical Castings.

Short cylinders or liners similar to Fig. 8, about 3 ft. long, 9 in. dia. and 6 in. bore, may be cast successfully, either green or dry, by a runner at the bottom entering at a tangent. This and the down-runner are large enough to fill the mould quickly, and so carry all dirt and sullage up to the top. The top may be left open and provided with an overflow, allowing surface scum to be skimmed off, or if closed extra head must be provided to take the sullage.

With thinner castings up to about 5 ft. long, a number of small runners dropping from the top provide the best method, the moulds not necessarily needing stoving, it being quite sufficient to dry the surface to a depth of an inch or more over a coke fire, with a piece of sheet iron over the top and slightly raised to allow steam to escape.

To provide for the first drop of the metal, the core may be increased in diameter for the last 4 in. at the bottom, the print being merely an extension of the pattern. As an alternative to this, a hard bottom may be provided by lining the print, of the same size, with segmental cores the same section as the metal thickness, and thus providing a print for a plain, straight core, as in Fig. 9. Moulds for similar castings, but of greater length, require stove drying, to enable them to resist the increased pressure of the metal.

In all cylindrical castings of these types, hot fluid metal is essential for cleanliness, the sullage created by the fall of the metal being then easily kept on the move by the falling metal, and prevented from clinging to mould or core. With dull metal the sullage forms into lumps, which become fixed and extend through the whole metal thickness, causing a bad bore and a bad outside.

Moulds of great length are divided into sections for convenience in stoving, and the top section may be provided with an extension at one side to serve for a pouring basin which may then be made up and dried along with the remaining sections (see Fig. 10). To close the top, after centring and securing the core, a ring core (in segments and fitting in a print around the outside) is then used, and this contains the necessary runners and a larger hole serving for the riser and to allow the air to escape from the mould. The covering cores are secured by sprigs driven into the mould and centre core, and a piece of loam branch core placed over the riser to prevent the metal going down and allow the air to escape.

An alternative method is to have a special section for the runner only, the top of the mould being closed by a plate, faced with loam and containing the necessary runner, riser and centre holes. After this is fixed, the pouring basin is made up with ordinary black floor sand, a separate compartment being left for the riser. Stops are used over the runners to prevent dirt entering before the runner basin is filled.

It is often found necessary, with castings of great length and thickness, to reinforce the sand used, with a special refractory sand, or ganister; also to provide an ingate at the bottom to supply metal to a depth sufficient to prevent the bottom being cut by the great height of the fall. When casting, the stops on the top runners are kept in place after the one covering the supply to the bottom runner has been removed, until it is judged that a sufficient quantity has entered by this means, they also being then removed.

Heavy Castings.

Castings weighing several tons are more difficult to control in respect to sullage, and as the presence of this creates weakness, inasmuch as it occupies space which should be sound metal, the strength of the casting may be seriously imperilled. To insure against this probability, extra ribs and brackets are often included in the design of an important casting, and thus actually the safety factor for jobs is increased. As the amount of sullage is added to, by sand washed off by the flow of the metal, this is limited as much as possible by avoiding inaccessible places at great depths, such places being difficult to repair if damaged by withdrawing the pattern. For this reason, amongst others, the whole of the centre of a mould may be formed by dry sand cores, or portions may be lifted out on special plates or grids, parts of the sides of the mould removed similarly being sometimes sufficient for the purpose.

By this means greater access for firming and finishing is provided, and the mould and portions may be dried with greater facility, should the quality of the job necessitate it.

Apart from these precautions and the location of the runners in the least important place practicable, attempts are made to prevent its appearance on the upper surface, as, despite all precautions, sullage will be present in castings of such a weight.

For this purpose, horizontal rows of wire nails are driven into the cores, about 1 in. apart, and at a point about half way up the sides, near the runner end of the mould. These serve to hold a good proportion of the sullage at this point, whilst allowing the good metal to rise and fill the upper part of the mould. These nails project across the mould space to the outer wall, and are also placed below other important parts, as facings, which require to be machined up clean.

In pouring all medium and large castings, which require to be clean, the use of stops is advisable, and the runner box must be reasonably deep to contain sufficient metal to prevent surface dirt being sucked down the runners. As an additional precaution, in removing flat stops, these may be held on the surface of the metal just above the down-runners, and the tendency to form a miniature whirlpool avoided, especially when pouring is nearly completed.

The actual capacity of the runner basin may be anything up to several tons, the latter where crane or ladle facilities necessitate the provision of a reservoir, sealed with stops protected by a coat of loam, to receive and hold the contents of one or more ladles until the last ladle is in position and ready for emptying.

As the depth of such a reservoir may be 2 ft. or more, straining and lifting of the cope require extra provisions, either by low-level risers to indicate filling of the mould, when further supplies can be immediately checked, by strong tie bolts secured to foundation plates beneath the mould, or by the more inconvenient method of applying dead weight.

Influence of Elements on the Red-shortness of Iron.

The American Bureau of Standards Technologic Paper No. 267, copies of which are obtainable at 10 cents each from the Superintendent of Documents at Washington, D.C., describes the influence of sulphur, oxygen, copper and manganese on the red-shortness of iron. The conclusions reached are:—

1. Sulphur is the principal element responsible for red-shortness. In order to prevent red-shortness in iron, not more than 0.01 per cent. sulphur should be present.

2. Oxygen in amounts up to 0.20 per cent. does not cause red-shortness in pure iron if the sulphur is below 0.01 per cent.

3. Manganese may prevent red-shortness in iron when present to the extent of three times the sulphur percentage if the oxygen percentage is not above 0.04 per cent.

4. The presence of considerable amounts of oxygen in irons (0.10 per cent. and above) tends to reduce the efficiency of manganese in preventing red-shortness. The hypothesis is advanced that this is because some of the manganese reported in such irons is present as oxide.

5. Copper (0.05 to 0.5 per cent.) is of minor importance in its effect on red-shortness of pure iron, but in some of the specimens described in this paper it tended to decrease the red-shortness.

Canadian Pig-iron Output.—The cumulative production of pig-iron during the eleven months ending November amounted to 570,000 tons. The average monthly output was 52,000 tons, compared with 75,000 last year and 32,000 in 1922.

Malleable Cast Iron.*

By D. Wilkinson, M.I. Brit.F.

The successful manufacture of malleable iron castings involves two distinct processes:—(1) The production of a casting which is hard, brittle and white in fracture; and (2) the modification, by heat treatment, of this hard and brittle casting so that it becomes soft, tough and ductile.

If the final product is to be of a good grade, the requirements of the second process call for definite limitations in the first. Not every white, hard and brittle casting can be malleablised. It is an easy matter to produce two castings between which the eye may not be able to detect any great difference, but which the annealing furnace will readily prove to be entirely different from each other; one retaining its brittleness under treatment, the other becoming ductile.

To produce the castings, furnaces of several types may be used; but this Paper will be confined almost entirely to castings produced from the cupola. A brief reference only will be made to one other type of furnace. For cupola-melted metal the following points should be noticed:—(1) The whole of the carbon must be in the combined form; (2) the phosphorus should preferably be under 0.06 per cent.; (3) the manganese should not exceed 0.2 per cent.; (4) silicon, while varying according to the type and size of casting should not exceed, say, 1 per cent. With this maximum in mind it may, for ordinary work, be kept as high as is consistent with obtaining a perfectly white fracture in every part of the casting. If the highest strength and ductility is required 0.5 per cent. should seldom be exceeded; and (5) sulphur, providing the pig is normal, need give little trouble. Excellent malleable castings are regularly made with as much as 0.45 per cent. of this element present. It may be noted a high sulphur should not be associated with a very low silicon, or difficulty may be experienced in the anneal. Also the higher manganese should accompany the high sulphur.

Grading.

Too much care cannot be given to grading the iron. For analytical control nothing but a complete analysis of each consignment of pig-iron is of real value. Partial analysis often proves to be a short, thorny road to the wilderness. As an example, a single experience of the pre-war days, which foundrymen are sometimes inclined to look back upon as the golden days when all pig-iron was good, can be cited. Two consignments of West Coast refined hematites were received under the following specification:—Silicon: under 1 per cent.; sulphur and phosphorus under 0.035 per cent. On arrival the complete analyses were found to be:—

	T.C.	G.C.	C.C.	Si.	Mn.	S.	P.
A	3.96	3.30	0.66	0.75	0.162	0.023	0.009
B	3.89	2.75	1.14	0.74	1.150	0.035	0.031

"A" was an all-grey iron with a fairly open fracture. "B" was a mottled iron of the sort called in malleable foundries "spotted grey." The complete analyses show the difference between the irons very plainly; but partial analyses, taking only silicon, sulphur and phosphorus, would be entirely misleading. The silicons are identical and are correct for the production of good malleable. The percentages of sulphur and phosphorus certainly vary; but the highest figure is so low that they may be ignored with safety. But neither of these irons would make good malleable castings. While the fracture of "B" would be correct for certain purposes, the high manganese would prevent successful annealing. With "A" where the manganese is correct, an all-white fracture could not be obtained, and any greyness in the casting is fatal to ductility after annealing. The analyses reveal no reason for the difference in fracture. The only element with any appreciable variation is manganese, which varies by nearly 1 per cent.: but neither experience nor research tells us that this amount of manganese will change a grey iron, with an open fracture, into a mottled one. Inspection of the fracture would instantly reveal the difference; and instances such as this form a strong argument in favour of retaining fracture as one method of grading.

It would be an easy matter to multiply examples similar to the above, but enough has been put forward to show the extreme care required to grade pig-iron so that good malleable castings may be regularly produced. It is safe to say that wherever records of analyses of refined irons are kept, an inspection of these records will produce instances where every sort of fracture, from all white to all grey, have had approximately the same silicon content; although in most cases the sulphur and total carbon contents would reveal the reason for the difference; while in the above example there is nothing in the analyses to account for it. For these reasons, a complete analysis, giving not merely the total carbon, but the combined and graphitic carbon also, is essential if maximum safety is desired.

Recognising that uniformity, while desirable, cannot be obtained, the following method of grading, for cupola-melted malleable, can be recommended as one which will prove reliable.

Each consignment of pig-iron, as it arrives, is stacked separately and fully analysed. When the charges are being made up in accordance with the analyses, instead of transferring the iron to the cupola platform immediately it is broken, let it be broken the day before it is required and each lot piled separately near its own stack with the fractured surfaces exposed to view. The fractures are then examined and any abnormal ones marked with chalk. These abnormal fractures are either distributed evenly through the charges, kept back to make up special charges, or rejected completely as judgment dictates. It may be noted that a fair amount of latitude in composition is permissible; and, by using a method similar to the above, the extreme variations that sometimes occur, and which always give trouble, can be definitely avoided. A cupola charge is so comparatively small that any decided variation in the pig is liable to be transferred to the casting with consequent trouble in the anneal.

This method of grading unites all that is good in the old style practice with the best of modern practice. It should not be forgotten that the old style malleable foundryman, despite his handicap, made a success of his work. There are firms who have been producing good malleable castings with regularity for nearly 100 years who even to-day do not possess a laboratory, and in which none of the staff possesses any considerable metallurgical knowledge. There are also firms, equipped with laboratories replete with the latest scientific appliances and staffed with men of high metallurgical attainments, who have abandoned the manufacture of malleable iron and are now purchasing it, in some cases, from the very firms who work by the so-called "rule of thumb." No scientific attainments can replace the skill which comes from the careful, prolonged and patient observation of the facts of everyday experience. But the greatest success will be obtained by the combination of wide technical knowledge with the practical ability only obtained by a close steady application to daily routine.

Cupola Practice.

The cupola practice may be considered good if the metal is hot and fluid. Speed of melting and low coke consumption, compared with hot, fluid metal, are of secondary importance. White iron, owing to its lower silicon and manganese content, is more susceptible to oxidation in the cupola than is grey iron; and when in this condition it not only gives trouble in the castings, but it freezes with great rapidity, skulling up the ladles and only about half filling most of the moulds. As a consequence great care and skill are necessary if a minimum coke consumption and a high rate of

* A Paper read before the Birmingham Branch of the Institute of British Foundrymen, Mr. T. Vickers presiding.

melting is to be obtained, and it is hardly wise unduly to economise in the cupola at the expense of the castings.

Foundry Practice.

Compared with grey iron practice the special points to be noted in malleable founding, while of great importance, are not numerous. White iron, having a higher contraction than grey, is more susceptible to shrinkage cavities and cracking. Successfully to meet these difficulties affords ample scope for ingenuity and skill. Shrinkage cavities are prevented by attention to the filleting and contour of the pattern, the provision of substantial feeders, a thoughtful disposition of the gates, and by chills. A feeder is preferable to a chill, unless it is quite certain a chill will eliminate the cavity and not merely move it to other parts of the casting. In general, a sounder product is obtained by using several small gates running into a thin part of the casting than by using a larger gate in a thicker part. When the whole of the metal enters the casting in one place and that place is a comparatively heavy one, the local "hot spot" thus produced is very susceptible to shrinkage. By breaking up the "hot spot" and locating it in a thinner part of the casting, greater uniformity in freezing is secured and liability to shrinkage holes is reduced. With regard to pattern design all internal corners should be filleted, and, where possible, an angle in the pattern should be replaced with a curve.

Cracks result from several causes. Sometimes they are started by shrinkage cavities, and in these cases the elimination of the cavity will remove the crack. At other times they are caused by the resistance of the mould, or the cores, to the free contraction of the metal.

Here the remedy is obvious. The worst cases result from unskilful design, and where this cannot be altered it is sometimes a troublesome matter to produce sound castings. There are two periods during which cracks form as the casting cools from the molten condition. As the metal freezes it passes through a pasty stage, and any opposition to free contraction during this state results in the tearing apart of the semi-solid particles, with the formation of a crack. After the metal has completely frozen, any considerable variation in section will induce irregularity of cooling and contraction, and the stresses thus set up may lead to cracks or even to complete fractures.

Attention to gating and chilling will frequently overcome this second difficulty. Where these fail, the addition of a thin bracket or web to the casting will sometimes prove successful. The bracket must be so proportioned that it will cool and contract more rapidly than the casting, and it must be so located that the stress induced by its contraction will oppose and neutralise the stresses induced by the irregular contraction of the casting. If these two ends are attained the opposing stresses will cancel out and the cracks or fracture will be prevented. It will be seen that considerable judgment is required to succeed in preventing cracks by bracketing. If these measures fail, the only thing to be done is to muffle the hot casting. Immediately it has solidified it must be taken out of the mould and placed in a muffle previously heated to bright redness. The heat of the muffle should be kept up for a little time, and it should then be cooled very slowly, and the casting not taken out until it is cold enough to handle. When carefully carried out, muffling seldom fails to secure success.

Cracks resulting from the first-mentioned cause —those occurring while the metal is in the pasty stage—are prevented by attention to pattern design, by chilling, or by bracketing. It is perfectly obvious a crack of this nature cannot be prevented by muffling. The casting cannot be taken from the mould until it has completely solidified, and by that time the crack has already formed. An alteration in the contour of the pattern will usually overcome this trouble. Where this cannot be done, a chill or a bracket must be used. When using a chill care must be taken not to make it too large, or another crack may form beyond the edge of the chill. A large chill may cause so rapid a freezing and contraction of the part to which it is applied that the adjoining wall of the casting, being still in a semi-solid condition, will be unable to withstand the resulting stress, and so will crack. One or more brackets carefully located and proportioned will frequently be found to be the easiest and best method of preventing this trouble. The brackets may be cut out after annealing.

An Experiment with Black Heart Malleable.

Before passing on to the annealing process the writer would like to mention an experience he had during the war with so-called unsuitable iron while producing malleable castings from a Siemens open-hearth furnace. During the time the shortage of iron suitable for malleable was acute a consignment of soft, grey hematite had been sent to the works. The silicon was 2.85 and the manganese 1.1 per cent. The firm considered it totally unsuited for use, and it was put on one side. While the writer was with the firm he suggested the iron should not be allowed to stand while hematite was so scarce, and obtained permission to try it for the production of malleable. The furnace had a capacity of 2½ tons, and a charge was made of the soft hematite with 10 per cent. of steel scrap. When the charge was melted, new annealing ore, carefully calculated to the amount required to reduce the silicon and manganese to the desired percentage, was added, a little at a time, to the slag. The heat proceeded in exactly the same manner as the earlier stages of a steel-melting heat, and before the last portion of the ore was added, test pieces were cast, carefully cooled, broken, and the fracture examined. No difficulty was experienced in limiting the ore additions to the exact amount necessary to reduce the silicon to a figure sufficiently low to give a completely white fracture. By the time the silicon had been reduced to 0.75 per cent. the manganese was found to be 0.3 per cent. The slag was then allowed completely to exhaust itself of oxide, when the metal was tapped and cast. By avoiding a strongly oxidising flame during melting the oxidation of the carbon was minimised, and the resulting metal, after annealing at 750 deg. C., yielded a good, tough blackheart malleable. The fracture of the hard castings was perfectly white, and could be distinguished in no way from the ordinary fracture of a hard casting. The whole consignment of iron was used in this manner.

Annealing.

The castings being made, they are cleaned and prepared for the annealing process. The oven in which this operation is carried out deserves careful consideration, but to investigate the various designs now in use would unduly prolong this Paper.

The manner in which the castings are packed in the annealing pans is a matter of importance if distortion during the process is to be kept at a minimum. The writer has more than once heard it said that it is essential to surround each one completely with the packing material, and to prevent them touching each other, if good annealing is to be secured. But he has never found this to be necessary. When associated with a malleable foundry his practice was, where the size and shape of the castings permitted, lightly to wedge them in shallow layers across the pans, filling the hollows and interstices with packing material, and ramming it down with short bars so the castings could not move.

The packing material is usually red hematite ore. The new ore is mixed with spent ore from a previous operation, in proportions which vary according to the size and grade of the casting and the position occupied in the oven. The proportions vary from equal parts to one in twelve or fourteen. The strongest mixture is used for the cooler parts of the oven and for the larger and harder castings. It is usual to expose the spent ore to the action of the air and weather, moistening it with sal-ammoniac and water. This weathering re-oxidises the reduced ore, so an economy in the amount of new ore required is obtained.

The consideration that ore is an oxide of iron once led the writer to try the oxidised scale that forms on the outside of the pans as a packing material. The scale was broken small, sifted, and used in the same way as ore. The results, on the whole, were satisfactory, although the elongation of the test pieces was slightly lower than usual.

With ore, up to 8 per cent. elongation was very frequently obtained; with scale, 6 per cent. was seldom exceeded. This reduced elongation was considered to be the result of the greater impurity of the scale as compared with the ore. For some years this material was used with success for cheap and unimportant castings, although ore was always used for important work.

All the pan joints should be luted inside and out, and made as completely airtight as possible. Defective luting is responsible for much spoiled work. It will be found an advantage to mix about 10 per cent. of the finest of the dust sifted from the spent ore with the fireclay mixture used for this purpose. This admixture considerably reduces the cracking and falling off of the outside luting during the process. It probably acts by forming a little ferrous silicate, which, being plastic at the annealing temperature, yields without breaking to the expansion and contraction of the pans.

The ideal annealing oven is one in which a uniform temperature can be maintained in every part from the beginning right through to the end of the process. It is to be feared this oven is still somewhere in the future. It is not impossible to construct, for laboratory use, a small furnace in which a uniform temperature can be maintained for an almost indefinite period, but to build and maintain at a definite heat a furnace large enough to hold a couple of dozen or more stacks of annealing pans, each 6 ft. high, is a problem of a different order. The annealer whose ovens do not vary from the roof to the floor by more than 10 to 15 deg. may count himself fortunate. Again, radiation will always prevent the outer stacks of pans attaining the same temperature as the inner ones. Careful firing will minimise these variations, but, even with the greatest care, complete control of the natural forces opposing uniformity cannot as yet be secured.

In view of the impossibility of obtaining a uniform temperature, it is fortunate that annealing will permit a fair latitude in this respect without seriously impairing either the strength or the ductility of the product. Unless an oven is badly designed or carelessly fired, there should be no difficulty in maintaining a temperature with a maximum variation of not more than 30 to 35 deg. C. between any two parts. It is not contended that an oven can be kept within these limits without trouble, but with good design, constant repairs and intelligent firing, even narrower limits are attainable.

The bringing up of the oven to the full annealing temperature of about 970 deg. C. should be done slowly. There is a temptation to save time by forcing the firing while the oven is cold, but few things are more productive of irregularity than too steep a temperature gradient at the beginning of the anneal.

Sufficient time should be allowed for the heat to penetrate to the centre of the stacks, so that a uniform expansion and increase of temperature may result. If the heating up is too rapid, the pans, which receive the full brunt of the flame, will expand away from the castings inside them. This gives rise to a double evil. The air-space between the expanded pan and its contents slows down the heat transference to the castings; since while the space lasts heat is transferred by radiation only, and not by radiation plus the conduction that occurs when the pan and its contents are actually in contact. In consequence there is a possibility of some of the castings not being properly annealed when the oven has run its full time. Also, as the castings begin to heat up, their expansion causes a settling down and a filling up of the increased pan space with a liability to some of the castings cracking, owing to interruption of their free expansion. When, later on, at full heat the carbon precipitation occurs, the lower layers will not have sufficient room for their final permanent expansion, and distortion will occur. A rate of heating sufficiently slow to maintain a uniform increase of temperature and expansion right through each stack of pans is an excellent preventive of under-annealing, distortion and oven cracking. Forty-eight hours is not too long a period to take in bringing an oven up to full heat.

As the temperature rises above 850 deg. C., its rate of increase should be still further slowed down. This is to prevent any part of the oven over-running the maximum temperature. Unless care is exercised at this stage, some of the upper pans may easily rise 40 or 50 deg. above the desired heat. Overheating of this character, unless immediately checked and reduced, produces badly annealed castings which, while not burnt, are not strong and ductile, but possess a fracture known colloquially as "rotten," an expressive and illuminating term descriptive of the result of overheating at the commencement of the anneal. The want of ductility is directly due to the premature precipitation of the carbon by overheating and to the flaky form carbon precipitated under such conditions always takes.

When the upper part of the oven reaches 970 deg. C. the increase in temperature should be stopped by adjustment of the firing and the dampers. At this period the variation of heat throughout the oven should be as little as possible; and in no case, if entire success is to be obtained, should it exceed 35 deg. This temperature should be maintained as evenly as possible until the annealing is finished and the time for cooling arrives.

Heat Control.

It is necessary to have some method of determining the temperature at which the oven must be held if the operation is to be a success; and this fact at once leads to the consideration of some form of pyrometer. As every foundryman knows, the eye, when trained by long experience, acquires a considerable facility in comparing and judging temperatures.

It is a common experience when regularly inspecting furnaces to turn to the pyrometer not so much for information as for confirmation of an impression already formed in the mind, and to find the pyrometer confirming that impression. But when accurate information can be readily obtained it is not wise to rely entirely upon judgment, however well trained it may be; and the assistance of some definite method of measuring the temperature of the oven is a necessity.

It is not easy to lay down the best method of securing pyrometric control of annealing temperatures. A radiation pyrometer gives excellent results with some furnaces, but the atmosphere of an annealing oven, which should consist of a slowly-moving smoky flame, interferes so much with the correct focus of the instrument upon the pans that low temperatures are frequently registered by it. If this type of instrument be adopted, it is usual to insert a closed fireclay tube through the wall of the oven and to focus the pyrometer upon the closed end of this tube. This cuts out the smoky flame, and when allowance is made for the lag in rise and fall of temperature, due to the tube, very reliable results may be obtained.

If a thermo-couple placed inside the oven is used it is necessary to guard against registering a fluctuating flame temperature instead of the true temperature of the pans. The only satisfactory position for a thermo-couple is inside one of the pans, where it will register the actual heat of the material undergoing treatment. But fixing it in this position is rather troublesome, and frequent renewals are usually required. The writer's preference is for a radiation pyrometer focussed upon the end of a built-in closed tube. When workmen have become accustomed to this type of instrument and to the lag introduced by the fireclay tube, it will be found very trustworthy. Needless to say, whichever instrument is adopted, it should be a registering one, so that the night firing may be checked.

It is in the highest degree necessary to guard against the error of working only to the pyrometer. The tendency is to consider all is well if the record is following the usual track. The pyrometer should be fixed at a point that readily comes up to heat; and the correct method is to use this location as a standard; and by attention to the fires and dampers to bring the remainder of the oven to uniformity with it. One accurate pyrometer is all that is needed; the trained eye, guided by the pyrometer, will readily determine variations in the remainder of the oven. A correct record should never be accepted as an excuse for poor annealing, and the conjunction of the two is by no means unknown.

Silver as Pyrometer Control.

As an occasional check upon the accuracy of matching the temperature shown by the pyrometer the silver melting test is useful. This is a very old test for annealing temperatures. Boyden, who is said to have introduced the manufacture of malleable castings into America, left on record his observation that the malleable annealing temperature coincided with the melting point of silver, and in at least one instance this test has been in occasional works so long that the time of its introduction has been forgotten. A piece of silver, preferably hammered into a thin ribbon and bent into a rough ring, is placed on a small fireclay dish and inserted in the part of the oven it is desired to test. Silver melts at 962 deg. C., so it is evident that if the correct annealing temperature has been established the ring will be melted. After a few trials it is fairly easy to estimate the approximate temperature by the rate at which the melting occurs. This test is sometimes used instead of a pyrometer, and if care be taken to maintain the silver in a state of purity by an occasional cupellation, it gives an exceedingly reliable indication.

It is also useful as a check upon the pyrometer to show when it needs attention and calibration.

The length of time the oven is maintained at heat may vary according to requirements. For castings of an ordinary grade in which the highest ductility is not required, 48 hours' bringing to heat, followed by 60 hours at heat and a slow cooling, will give good results, provided a suitable composition is obtained in the hard casting.

If maximum ductility is required the silicon and sulphur content of the castings should be kept down and the period at heat lengthened. With a silicon of 0.5 to 0.6, a sulphur between 0.2 and 0.25 and period of 72 to 84 hours at heat, followed by slow cooling to 600 deg. C., excellent ductility may be obtained. The longer anneal reduces the carbon content more than usual, and, providing the upper limit of 970 deg. C. is not exceeded, a very ductile malleable results. A standard works bend test for this annealing treatment was a bar 9 in. long by ⅜ in. dia. These bars regularly bent to 180 deg. round a ½ in. radius without the least sign of a crack appearing.

The Chemistry of Annealing.

The reactions by which the carbide of iron in a hard casting is decomposed during annealing, its carbon being partly removed and partly deposited as temper carbon, are undoubtedly much more complex than they are usually considered to be. The commonly accepted explanation is as follows:—

As the oven comes up to heat, the oxygen of the air enclosed in the pan, diffusing through the skin of the castings, combines with the carbon of the cementite it finds there forming CO_2.

$$(1)\quad 2O_2 + 2Fe_3C = 3Fe_2 + 2CO_2.$$

As the ore is heated up it is decomposed into mixed oxides and oxygen, and this oxygen also reacts with the cementite and forms CO_2. The mixed oxides remaining are of a variable composition, so that it may be better to leave the numerals indefinite and write the formula Fe_xO_y. With increasing temperature, a small amount of the furnace gases containing a proportion of CO_2 and CO will diffuse through the pans, and the ore will oxidise the CO to CO_2.

$$(2)\quad Fe_x\,O_y + CO = Fe_x\,O_{y-1} + CO_2.$$

By the time the oven is up to heat a fair amount of CO_2 will be present in the pans. As this gas diffuses into the castings it reacts with the cementite:—

$$(3)\quad 2Fe_3C + 2CO_2 = 3Fe_2 + 4CO.$$

The ore immediately adjoining the castings oxidises this CO, as it diffuses outward, into CO_2 in accordance with equation (2). The cycle of reactions (2) and (3) proceeds slowly but continuously, having as an ultimate issue the removal of carbon from the outer part of the castings.

The precipitation of temper carbon is usually considered to result from the unstable condition of the cementite. This instability is inherent, and is increased by the action of the silicon present.

When cementite is maintained for a sufficient time at a sufficiently elevated temperature it slowly coalesces into nodules, and finally arrives at a condition of equilibrium by decomposing into iron, in the state of ferrite, and carbon. The carbon, owing to the mechanical opposition of the iron, is unable to coalesce into flakes, but remains, *in situ*, in patches of temper carbon.

Recent research has brought to light facts which appear to modify these views. At the autumn meeting of the Iron and Steel Institute in 1923 a Paper was presented by Honda and Murakami on "Graphitisation of Iron-Carbon Alloys." Working on a pure white iron with a silicon content of only 0.063 per cent., these investigators appear to have proved that graphitisation is the result, not of a movement of cementite towards equilibrium when under the influence of heat, but to the presence of traces of oxides of carbon in the alloy and to a well-known catalytic action which occurs when the oxides of carbon and iron are in contact at an elevated temperature.

In the upper regions of the blast furnace a well-established reaction occurs, due to this catalytic action, which may be represented by the following equation:—

$$(4)\quad 2CO = CO_2 + C.$$

The carbon monoxide decomposes, forming carbon dioxide and depositing solid carbon. This reaction only occurs in the presence of iron, upon which the carbon is deposited. The investigators appear to have proved that this catalytic action occurs at temperatures as high as 1,100 deg. C. When it occurs within an iron-carbon alloy, the resulting dioxide will at once react with the cementite it finds there, as shown in equation (3), and the newly-formed monoxide again undergoes decomposition by catalytic action, as shown in equation (4). So the cycle of reactions will continue; and as a final result there is the reduction of cementite to metallic iron by reaction with the dioxide, and the deposition of solid carbon in a finely divided form by catalytic action between the monoxide and iron.

If these facts are applied to the annealing of malleable iron, the reasons for the removal of carbon from the outer part of the casting and its precipitation in the interior part become clear. At a high temperature there is, at the outer part of the casting, a system capable of chemical action, containing oxides of carbon, iron, carbide of iron, and a large excess of mixed oxides of iron in the ore.

At ordinary temperatures these bodies would remain in contact, without change, indefinitely, but at the annealing temperature chemical affinity comes into play, and, knowing the composition of the bodies present, it is possible to predict the direction of the various reactions towards equilibrium. The excess of oxides in the packing will determine the movement towards a simpler system consisting of carbon in its maximum state of oxidation—that is, carbon dioxide—iron, and the excess of mixed oxides, with the disappearance of carbon monoxide, carbide of iron, and a portion of the mixed oxides of the packing. Hence the removal of carbon from the outer part of the casting. As the gases penetrate further into the casting, they pass beyond the oxidising influence of the packing, and so the point of equilibrium will change. Chemical action would now establish equilibrium between carbon monoxide, carbide of iron and iron were it not for the catalytic action which occurs under these conditions, decomposing the newly-formed monoxide into dioxide and carbon.

So we have the continued alternate chemical and catalytic reactions until the carbide of iron disappears and equilibrium is established between the monoxide, carbon and iron.

The result is that in the annealed casting the greater part of the carbon is concentrated in the centre of the section in a very finely-divided form, while the outer part of the section is almost carbon free.

The partial removal of carbon from the centre of the casting is also accounted for. At the annealing temperature part of the carbide goes into solution in the iron, and diffusing outward, comes into the range of the oxidising influence of the ore, and so is removed.

It is evident that the action of manganese and sulphur in retarding annealing is by interference in the reaction between the dioxide and cementite; while the action of silicon is to facilitate this

reaction. The carbide of iron appears to be perfectly stable under heat, providing there is a complete absence of the oxides of carbon.

Yet further light on the mechanism of annealing may be obtained from recent researches on the action of hydrogen on steel. During the last few years several Papers on this subject have been read before the Iron and Steel Institute, and it is definitely established that hydrogen, especially when it is moist, will decarburise steel at a temperature of 950 deg. C. Its action is:—

(5) $4H_2 + Fe_3C = 3Fe_2 - 2CH_4$.

When it is considered that the ore used in annealing is usually moist, it is evident the hydrogen resulting from the decomposition of the moisture will also have an action on the malleablising of cast iron. As shown by several published analyses of gases taken from annealing pans, both hydrogen and methane are always present in them. It must be borne in mind that the equilibrium pressure between the two gases H and CH_4 will determine the amount of carbon removed by this agency. But it must also be remembered that the complex interaction of the components actually present, and the reversible reactions that occur under a varying equilibrium, may have important but as yet unknown results upon the process. A continual regeneration of hydrogen from the hydro-carbon gases is not impossible, and it may ultimately be found that the moisture content of the ore has a definite bearing upon the success of the process.

DISCUSSION.

Opening the discussion, the Branch-President (MR. T. VICKERS) commented on the decline of the malleable iron industry in this country, and thought there must be some definite reason for it. There was a time, he said, when this country were the largest exporters in the world; now it occupied about the fifth position in output. Great Britain manufactured about 60,000 tons of malleable iron per annum, compared with America's about one million tons. It employed something like 6,000 men in the malleable iron foundries, against approximately 35,000 employed in America. One source of satisfaction was that America owed its success to the initial work of an Englishman, Seth Boyden, who left the Bilston area for America and started their malleable iron work. This was the beginning of America's success. It was extraordinary how varied was the practice, and malleable iron founders needed more information as to the working of their annealing ovens. As to packing, some packed exceedingly fine, and others favoured very coarse packing; some packed in a loose way, and others as tightly as possible. There ought to be some definite rule as to which was the better practice. Further, they needed precise information on such matters as the temperature of the oven, the time of annealing, and the rate of cooling. It was remarkable that there was no really good English book for the guidance of the malleable iron founder. They had to go to America for their information. In these circumstances Mr. Wilkinson's lecture was particularly useful.

MR. H. FIELD, referring to the weathering of the ore, which was said to be an economy, did not think such economy was necessary, as the difficulty seemed to be to get old ore. It might almost be said that they ought to hasten the spending of the ore so as to accumulate a good stock. In the Walsall and Willenhall area they were constantly being asked if old ore could be supplied. Regarding recording pyrometers, Mr. Field feared that where there were six or eight annealing ovens, to have them all fitted with recorders would necessitate an outlay which was beyond the means of the small iron founder. One question which Mr. Wilkinson did not dwell upon was that of economy in annealing pans. Of all the expenses in the malleable iron foundry there was none which seemed so wasteful as the continual scaling of annealing pans during the process. There seemed to be a tendency for malleable castings to get heavier. He considered that by being asked for sections which were too thick the malleable industry was being done a considerable injury.

MR. E. R. TAYLOR said the metallurgist could be of very great assistance in the malleable iron trade, which seemed to be slow in coming into line with scientific progress. There must be no distrust, however, between the metallurgist and the man in charge. In the malleable iron trade there seemed to be no end of tests applied in the way of bending and twisting, but it was desirable that they should be standardised. Some effort had been made by the British Engineering Standards Committee to standardise certain test bars in the malleable trade, such as the bend and tensile, and specifications called for a bend of 45 deg. in white heart. In that case the test bar must be of a definite size—$\frac{3}{8}$ in. thick and 1 in. broad. That was a very useful step forward, and was an attempt to formulate some standard test to which people could work. As regarded elongation, it seemed to him it would be very difficult to get. Some people said they could get 8 per cent. every time, but if they did, something else was bound to suffer. He found it easy to get 20, or even 25, tons tensile, but elongation began to fall off so severely that they were liable to find themselves outside the specification.

MR. A. PARSONS inquired as to the length of time after the heat-up that it took to anneal, and how long castings should be left in the furnace after the annealing was complete, to cool down before being drawn. He was referring to castings which were not over half-an-inch thick.

THE CHAIRMAN, alluding to physical tests, pointed out that in America they obtained 25 tons per sq. in. easily, with 20 per cent. elongation.

On the motion of MR. J. B. JOHNSON, seconded by MR. F. C. EDWARDS, a cordial vote of thanks was passed to the lecturer. Mr. Edwards, referring to patterns, emphasised the importance of good, big fillets being put in, because with white iron there was greater possibility of shrinkage cracks.

Replying upon the discussion, MR. WILKINSON expressed surprise that there should be any difficulty in obtaining old ore. When he was in a malleable foundry, he said, they used regularly to throw it out. He agreed that the expense of introducing pyrometers was considerable, but pointed out that even then it was an economy if by their introduction bad malleable castings were avoided. Many firms lost a considerable amount by defective annealing, and this might be obviated by using pyrometers. He did not agree with Mr. Field's observations on the subject of the thickness of malleable iron castings. The great variety of test bars was one of the evils of the trade. It would be a great advantage to have them standardised. To obtain really good elongation, the annealing must take time, after which 35 hours should be allowed for the cooling down. The pans should not be drawn until it was possible to just touch them with the hands. He had a decided preference for annealing by gas. Gas was under better control; they could heat with more regularity and maintain the heat with less trouble than was possible with coal.

Foundry Queries.

Small Melting Plant for Steel Castings.

I should be very grateful if any of your readers can inform me of the best mixture and method of making steel castings in small quantities, say up to 10 cwts., any individual casting being not more than 1 cwt. An electric furnace is out of the question, as we have no available current. We should like something simple, and, if possible, to produce a casting which does not require annealing.

We are prepared to place an order for such a plant if a guarantee is given that it can be installed and to do the work satisfactorily.

We do not wish our name to be divulged in this instance, and should like any communication to be submitted through THE FOUNDRY TRADE JOURNAL.—S. K. E. B.

Cost of Lining Cupolas.

(*Issue December* 11.)

Regarding the lining of the cupola, I have consulted the brick works in the North of England, and, of course, it depends on the height of the cupola.

According to details received, and basing on a suitable quality of brick made in the Newcastle area, I take it that it would cost 25s. for every yard, *i.e.*, if a cupola is 21 ft., this would be seven times 25s.—H. SHILLITOE.

Some Aspects of Foundry Costing.*

By John Spittal.

On approaching this subject of foundry costing it is pointed out that these remarks are not addressed particularly to cost accountants as such, nor is it the intention to put forward any fully detailed scheme of costing, but an endeavour will be made to interest the moulder and his foreman in this department of the foundry organisation, and to outline some general principles which govern the question of foundry costs from a practical standpoint.

We are past the days now for considering whether the foundry really requires an efficient costing department or not, because most employers have long since realised that a properly run business cannot afford to be without one. Those in the position of knowing will agree that the lack of co-operation between the pattern shop and the foundry is reflected almost immediately in the cost records, and that but for these records, the undesirable conditions often referred to may go on for some time unsuspected.

One has to consider not only the actual mistakes which occur owing to the absence of sympathetic co-operation—these mistakes usually come into evidence during the progress of the work through the shops when they have to be put right—but there is also to consider the general production efficiency in the foundry suffers to a very marked degree, because before the job reaches the foundry, one department has passed on his work to the next, without troubling very much what interpretation the other may put upon his details, or what difficulty may be encountered in the production of the work in the departments subsequent to his own. It is here that the cost accountant, who realises the service he can render the management with detailed costs, will so arrange his scheme of work that comparative costs can be produced at any time, setting forth the production efficiency of one class of work, where designs are adopted having regard to the capabilities of labour and the facilities otherwise available, as against similar work where through inefficient co-operation, these considerations have not been taken into account. When conditions exist which retard the moulder in the efficient performance of his work, and these can be expressed in money terms, it will be found that the subject assumes an altogether different aspect, and in all probability not only the design of the patterns, but their construction also, will receive more sympathetic consideration, from the moulder's point of view.

There is an unhappy idea in the minds of many moulders—not excluding sometimes their foremen—that the cost department (whatever its functions may be) is not their friend, and the less it gets to know of what goes on in the shop the better it will be for all concerned. That is an altogether mistaken idea, but at the same time one must admit that the moulder is not wholly responsible for this unfortunate attitude, and there have been, no doubt, many occasions where the moulder has been thought at fault, when he was really working against conditions over which he had no control.

Where Economies May be Effected.

When costs are high on a particular class of work and it is found that the direct wages are perhaps more than they should be, it is certainly not good policy to consider the reduction of the wages cost as the first step towards economy. It is generally agreed that that should be the last resource, because on investigation, it probably may be found that the man is working with unsuitable gear or with shoddy patterns, while on the other hand it might be the case that the man is on a class of work to which he is at first unaccustomed. It will be seen therefore that all cost statements should be examined with care, as one can be quite easily led to wrong conclusions, and in this connection it may not be out of place to remind those in charge of foundries, that it is much the better way, that their criticism of costs is first discussed with the accountant before the men actually on the job are approached on the matter.

The work of the cost department covers an important requirement in all business establishments, and in a foundry concern, where castings of a fairly wide variety are produced, it is necessary to have a suitable system of costing in operation if the business is to be a success. In such a system the principle on which the oncost charges are allocated should be such that each job or each group of work bears only its own legitimate share. Foundry costs raise problems peculiar to themselves, and in no other department of an engineering establishment are the same difficulties encountered. The reason is obvious, of course, that whereas the foundry is actually producing all kinds of articles by bringing them into shape and being from the raw material in the form of pig-iron and scrap, the machine shops and other departments are merely carrying out the finishing details on work already produced by the moulder. Even in the smithy and structural shops the material there worked upon, *e.g.*, M.S. plates and sections, are already manufactured before entering these departments. It can be appreciated therefore how the foundry has problems in their manufacturing costs that do not arise in any of the other departments, and in order to obtain satisfactory results the method of costing the foundry output requires to be carefully considered. In a general engineering works having their own foundry it will be found advisable to separate the foundry so far as costing is concerned from the other departments, and with a little reorganisation this can be accomplished quite satisfactorily.

The foundry section of the establishment should comprise all the departments concerned with the production of the casting from the point where it leaves the drawing office to the point of its delivery either to the machine shops or to the despatch department, and it would therefore include:—(1) Foundry planning; (2) pattern shop and pattern stores; (3) the foundry proper subdivided as follows: (A) cast-iron section; (B) non-ferrous section; (*a*) Greensand moulding; (*b*) Dry-sand and loam moulding; and (*c*) coremaking; (4) dressing shop; and (5) foundry office.

One of the principal duties of the planning department is to aim at complete co-operation between the designer in the drawing office and the moulder in the foundry, also between the pattern shop and the foundry. The planning department therefore studies the requirements of the designer always from the foundry point of view, with the object of ensuring that the work coming into the foundry is such that the moulder can be reasonably expected to carry out in an efficient manner. When the details of the work are definitely fixed, this department will pass on to the patternmaker all the necessary particulars relating to the design and construction of the patterns, not forgetting that it is possible to have a design which is technically right but commercially wrong. The cost department would be in the position of giving details of the cost of previous work of a similar nature for the guidance of those concerned, so that the work may be designed on economic lines.

Importance of Accurate Records.

It is customary in all special jobs to give to each unit a definite part number, and in all standard work to give a definite pattern number, and these details should be noted in the time records taken in the foundry, so that when any departure is made from the standard or the original design, necessitating the employment of a different method of moulding, the separate cost can be obtained. The same arrangement, of course, is carried out in the engineering shops, thus giving the cost department the necessary information for providing the cost of any particular part of the complete job. The workman can therefore appreciate the fact that if the time-clerk appears to be too particular about these seemingly needless details there is a

* A Paper presented to the Scottish Branch of the Institute of British Foundrymen, Mr. Affleck presiding. The Author is connected with the Argus Foundry Co., Ltd.

reason, and both the moulder and his supervisor can do much towards the accuracy of the costs without going out of their way to do so. When reliable costs are available the employer can concentrate upon that class of work which his foundry is best suited to produce cheaply. He can also see what jobs are likely to be unremunerative while the order is still in progress, and so get matters adjusted if possible. In turning attention to foundry costs, it will be at once apparent that the various processes by which casting are produced vary to some extent in cost. The three processes in general use are, of course, greensand, drysand, and loam moulding, and it is not a difficult matter to arrive at the cost of each group if a carefully prepared scheme is adopted. Such a scheme would necessarily require to provide for the collection of all items of cost relating to metals, labour and oncost charges, and to allocate these correctly to the three groups of work named, *i.e.*, greensand, drysand, and loam. In many foundries where only a few loam jobs are undertaken, the drysand and loam groups are classified as one, leaving only the two groups to be dealt with.

found best to keep this under a separate account. The metal cost for the iron output would be therefore arrived at by pricing the consumption of the various brands of iron and scrap; to the overhead rate per cwt. is added the melting loss, represented by the amount of waste matter, etc., in the pig-iron, usually taken about 5 per cent., and adjusted at the close of the month when the stock returns are available. The systematic control of the cupola has been frequently discussed at foundry meetings, and it is gratifying to find an increasingly large number of foundries all over the country where the cupola is treated with that respect to which it is entitled. No one knows better than the foundryman that the cupola has a nasty way of reminding one when its importance is temporarily overlooked. This control of the cupola has assisted the accountant in many ways, principally because he can now obtain accurate returns for every cast. Each charge of metal is weighed, its composition being clearly stated, so that at the end of the day's melt the accountant knows exactly the tonnage of the various brands of iron which have been used, the weight of coke

ELEMENTS OF FOUNDRY PRODUCT COSTS.

(1) METAL COST.			(2) DIRECT WAGES COST.			ONCOSTS.
Brand.	Weight.	@ £ s. d.	Total Hours.	Class.	Amount.	(3) MELTING COSTS: (*a*) WAGES:— Labourers. Cupola attendants. (*b*) Fuel. (*c*) Stores. (*d*) Upkeep of plant. (*e*) Power cost. (*f*) Depreciation.
S. T. W. Y. Z				Moulding £		
				Closing £		
				Coremaking £		
		£		TOTALS .. £		(4) DRESSING COSTS: (*a*) Wages of dressers and sand-blast operators. (*b*) Stores. (*c*) Upkeep of plant. (*d*) Power cost. (*e*) Depreciation.
ADD.: Melting loss at 4.6%		£				
— per cwt.						(5) GENERAL SHOP CHARGES: (*a*) Indirect labour. (*b*) General stores. (*c*) Power cost. (*d*) Repairs and renewals. (*e*) Loose tools. (*f*) Foundry staff and management. (*g*) Depreciation.
MELTING LOSS THUS:—	Weight.					(6) DEFECTIVE PRODUCTS.
Pig-irons, etc., used..						
Less returns (shop scrap)						(7) ESTABLISHMENT ONCOSTS: (*a*) Staff and management. (*b*) Taxes, insurances, etc. (*c*) Depreciation. (*d*) Commercial oncosts, advertising, etc.
Net consumption ..						
CASTINGS OUTPUT ..						
Melting loss ..						
—4.6%						

CHART I.

The following items comprise the production cost of the foundry output as follows:—(1) Metal cost; (2) direct wages; (*a*) moulding; (*b*) closing; (*c*) coremaking; (3) melting costs; (4) dressing costs; and (5) general shop charges, comprising: (*a*) indirect labour; (*b*) general stores; (*c*) power costs; (*d*) repairs, renewals and maintenance; (*e*) loose tools; and (*f*) foundry staff and management; (6) defective products; and (7) establishment oncosts, which are (*a*) office staff and management; (*b*) rates, taxes, and insurance; (*c*) depreciation; and (*d*) advertising, etc.

Before going into the question of how the sums expended in the production of the castings are distributed over the work produced, the various items of expenditure just enumerated will be considered.

Metal Cost.

This refers to the cost of the various metals or brands of iron required to make the castings. There are various methods of arriving at this cost. In some foundries it represents the cost of the molten metal in the foundry ladle, *i.e.*, the expense of the melting is also included. Personally, the author prefers that the metal costs should be only what it purports, and as melting is a distinct process in the making of the castings, it will be consumed, and the amount of fluxing material, etc., introduced. When the metal cost is arrived at in the manner described, the effect of any fluctuation in the price of the iron or any particular brand of iron used is always apparent; but this could not be said if the melting cost was always included, as one then might often find it to be the case that the molten metal cost was the same for two consecutive months; whilst as to the fact in one of the months iron was probably at a lower cost, the consumption of fuel or some other item was higher than formerly.

Direct Wages.

The second item, direct wages, is the amount expended on moulding, closing and coremaking for the month, against the various orders on hand. In dealing with this part of the subject, it should first of all be decided what method of time recording is to be adopted. In the large majority of shops these records are taken daily by the foundry time clerk going to each moulder and getting details of his work for the day, and although this may be a quite satisfactory arrangement in many foundries, something different may give much better results in other shops. A good arrangement where it can be conveniently carried out is

to provide job cards for all orders coming into the foundry. Each card represents a definite "job" to a certain machine or a certain workman. These cards are arranged in the foreman's office in such a manner that he has constantly under review the various classes of work coming forward classified into suitable sections relating either to the different machines or to the various charge hands in the shop. The cards can be further arranged in order of priority, so that the more urgent work gets earlier attention. They are issued to the supervisors early in the day for the following day's work, so that the pattern store may be advised what is required in the way of patterns, and the supervisor can see also that the necessary cores are forthcoming in good time for the man employed on closing the moulds. The core department should be working at least a day ahead of the moulder, and where standard work is in constant demand the supervisor in the core department can always fill in odd minutes in such work, the cores thus made being kept in the core store until requisitioned. These job cards give all the information the workman requires in order to proceed immediately with his work, and are particularly serviceable in dealing with repetition work, the number being made each day being shown, also the balance required to complete the job. The card also carries the record of bad castings in the foundry, giving under symbol reference the cause of rejection, and in this way a complete history of the job from start to finish can be seen, whilst the number of rejects and the cause are kept under the notice of the moulder during the progress of the job towards completion. In some cases a moulder may have two or three cards representing his day's output, whilst on the other hand one card may last for several days. The foundry clerk checks the number of moulds made at the close of the moulding shift, and enters on the card the details already referred to, transferring the particulars to the workman's weekly output record. This record states whether the job is in greensand or in drysand, and gives generally all the information required for costing purposes, the wages on each job being extended separately, the total for the week agreeing with the gross wages earned. In this way complete agreement is maintained between the wages account in the general ledger and the amounts entered through the costs, as shown in the wages analysis. This analysis will be referred to again under the heading of indirect labour.

Melting Costs.

The third item, melting costs, deals with the pig-iron and scrap as received from the yard stock until delivered at the cupola spout. The items comprising this cost would therefore include: (*a*) Labourers' work, breaking the pig-iron and scrap, also weighing the iron and coke charges for the cupola; (*b*) cupola attendants; (*c*) fuel; (*d*) stores, refractory materials, limestone, etc.; (*e*) relining cupolas and upkeep of plant; (*f*) power costs; and (*g*) depreciation.

The total expenditure ÷ output of castings gives the rate per cwt. for the melting cost.

Dressing Costs.

The fourth item, dressing costs, include:—(*a*) Total wages expended in this department; (*b*) general stores; (*c*) upkeep of sand blast plant, etc.; (*d*) power cost; and (*e*) depreciation.

In regard to the allocation of this expenditure the author has never found it a practical proposition to deal with this as a *direct* charge, *i.e.*, taking the actual time the dresser is employed on each casting. In order to give full liberty for encouraging the output of work, the foreman should be able to clear up his day's cast in as straight ahead manner as possible, leaving it to the foundry despatch department to collect, apportion and weigh up the castings. There are foundries to-day where the large proportion of the foreman dresser's time is employed apportioning the work for his men so that the time may be lifted with some degree of job sequence, finding the orders to which the castings belong, even weighing the castings and making out the daily output, all work which has really nothing in common with dressing a casting or supervising others so engaged. In some foundries the expenditure on dressing is allocated at an overhead rate per cwt., but there is great doubt as to the correctness of this method. One can personally observe work in almost any foundry where the weight of the casting caused the dressing cost to work out at about 15s. when only half an hour was required for the job. On the other hand, one has seen castings where the rate per cwt. brought out the dressing cost at a few pence, but the actual time taken was two hours. As a general rule, it will be found that the allocation of the dressing cost on a direct wages basis brings out a much more reliable cost, for, after all, it is a very reasonable conclusion to arrive at, that the longer the moulder takes to mould a job the more core work there is, the dresser will spend a correspondingly longer time at his part of the work. It would appear, therefore, that the allocation of this expenditure in proportion to the direct wages on the job is the correct procedure.

General Shop Charges.

The fifth item, general shop charges, includes all those items of oncost already enumerated, and deal only with expenditure over which the foundry manager has control. The first item under this heading refers to indirect labour. By indirect labour is meant, of course, all labour not directly engaged on a definite productive order. The moulder and his assistants are engaged directly producing certain castings; such labour, therefore, would be classified *direct*, as distinct from *indirect* labour, which comprises, for example, the men employed at sand-mixing, electric cranemen, etc., who are helping production more or less indirectly, although nevertheless essential. The method of dealing with indirect labour presents no special difficulty. It may be necessary in some foundries to lift this time in the same manner as with direct labour, but it may also be arranged by means of suitable grouping the names of the workmen on the pay roll, and by departmental totals. In any case, an analysis of all indirect labour should be kept each week and compiled monthly, so that in the event of this item being questioned at any time, it can be shown how the labour has been employed. As the indirect labour costs in the foundry form a substantial percentage of the total foundry cost, it is obviously necessary to keep control over this item, and the accountant should be in the position of showing how the money has been actually expended.

The complete wages analysis comprising all classes of labour should show the proportions against the greensand and drysand departments, also the core department separately, and would be prepared somewhat on the following lines:—

A. *Direct Wages.*—(1) Moulding; (2) closing; and (3) coremaking.

B. *Indirect Wages.*—(1) Skilled labour employed indirectly:—(*a*) Supervision; (*b*) apprentice training and schoolroom; (*c*) sundry work making test bars, etc.; (*d*) experimental work; (*e*) overtime allowances; and (*f*) lost time through breakdowns, etc. (2) General labour in foundry:—(*a*) Supervision; (*b*) general labouring; (*c*) electric cranemen; (*d*) sand preparation; (*e*) pouring; (*f*) cleaning up and shop preparation; (*g*) drying stove attendants; (*h*) storeman; (*i*) blacksmith. (3) Core department:—(*a*) Supervision; (*b*) pasting and storing cores; (*c*) core stove attendance; and (*d*) sand mixing and preparation. (4) General:—(*a*) Cupola attendance; (*b*) brass melting furnacemen; (*c*) dressing and sand blasting; and (*d*) repairs and maintenance of plant.

The grand total of this weekly analysis agrees with the wages account in the financial books.

(To be continued.)

Manganese Ores in the Caucasus.—At the recent annual meeting held in Paris of the Mines de Manganèse de Darkvéti (Caucase), the president informed the shareholders that the Company's mines in the Caucasus are still "nationalised" and held by the Soviet Government, who have made an offer to the Company allowing the latter to resume mining operations at a rate of up to 500,000 tons per annum, of which the company may retain 6,000 tons, or 1.2 per cent. The Company has naturally declined the offer. A powerful American combine, who attempted to acquire the monopoly of manganese output in the whole of Russia, has also been unsuccessful.

XUM

The Choice and Use of Pig-iron by Modern Methods.*

By H. J. Young, F.I.C.

In 1921 the author wrote a Paper with the object of stimulating interest in the production of cast iron to meet the requirements of modern engines, such as those of super-heated steam and internal-combustion types. Such iron must withstand high temperatures, and, in addition, must wear well when called upon to do so, as in the case of such castings as, say, cylinder liners. The author, having had considerable experience of such matters, thought he could place on record certain points which would be of value to others trying to do likewise.

Consequently the opening pages of that Paper were devoted to presenting proof of the great and astonishing variations occurring from consignment to consignment, and throughout each consignment, of such ordinary brands of pig-iron as had come his way. Tables were given showing and proving that the same serious unreliability existed uninterrupted by war conditions or lack of them. Further, these tables demonstrated the valuelessness of the makers' advertised analyses; also that the extent of the variations exceeded all reasonable proportions.

The author pointed out that, so far as his experience had gone, the only control of cast iron was that one obtainable by the control and understanding of its composition. In support of this statement he gave instances of castings, made from time to time from various brands of pig-irons, alike in composition and physical tests.

To the author's surprise, at that period the above subject aroused much opposition. Hence, later on, before the Foundry Exhibition last June, he ventured upon a short Note dealing exclusively with it. Here he received a greater surprise, because the attack was so virulent that THE FOUNDRY TRADE JOURNAL declined to publish some of it, as being too personal.

It is evident, therefore, that further and constant ventilation of this question, of vital importance to both ironmaster and ironfounder, is essential to the welfare of the trades concerned.

Cast iron, high-class cast iron, can be controlled by composition, and by no other means known to us at the present day. Control by composition does not mean control by analysis alone; no chemist or physicist would be foolish enough to assume that. The foundryman will need to realise that cast iron is not a mixture from which one can pick out or put in so much silicon, phosphorus, sulphur and manganese. Silicon, phosphorus, sulphur and manganese do not exist in cast iron save as compounds, often very complex compounds. Therefore anyone who says that this is *a plea for the analyst* is falling into an error which may have the force of a gibe, but certainly no more.

Keep and Turner taught us things which even to-day are unassimulated by many people professing to be authorities on the subject. In the course of one's work it is possible to find more shrieking over freak results than attempts to understand and produce normal ones. Everyone has met with many things difficult of explanation; old-time wizards did a good and false trade upon no other foundation than that truth. A man who knows little can be convinced by not much more. The writer has seen inquests held upon castings where the whole matter turned upon one person having a small hand-glass and possessing the power of "seeing things" through it; moreover, he always saw what was in his favour, and made his audience see likewise. Thousands of castings are judged in this manner, and pig-iron, more often than not, is sold under similar conditions.

Once again let it be said that high-class cast iron cannot be judged in this way; nor can the pigs from which it is made. Not a few foundries and ironworks will become derelict because they cannot hear the new ringing out the old; it is a sound to which no sense is acute save common sense.

When one sends a casting out upon the seas, as with a marine engine, one is inviting a test more searching than any other. The iron in the casting must be of the correct analysis, composition, microstructure, and physical properties. When this ship comes home it may be that the engines will be examined, the cylinders opened out, and very accurate measurements made. These are tests in the true sense of the term, and are established practice in jobs such as Diesel engines.

Suppose a casting is found to have given very good or very bad service. What use would it be to attempt to remember the fracture of the particular pigs which went into the cupola when that casting was made three years ago? What hope would there be of obtaining another batch of fractures to match? Such methods are as fantastic as the Chinese custom of lighting candles around the mould.

The astounding thing is that anyone can be found to swallow such nonsense. The average foundryman uses the same mixtures, no matter how much may vary the fractures of his irons—and vary they do. He may profess to judge by fracture, but in the course of the author's experience he has found none who did. He has met only that man who works by rule-of-thumb mixtures which are at the mercy of the constant fluctuations of the various pig-irons used. These fluctuations are actually greater, on the average, than are those in the scrap iron on the average. Of course, very common pig-iron does not vary so much as the superior kinds. Common iron is not likely to get better, and can get hardly worse. The word "common" is not used here to mean anything other than cheap and ordinary; it does not mean *bad* iron.

The man who judges both his pig-irons and his castings by fracture is similar to one setting up a blind judge and jury and instructing them as to whether the accused looks guilty or innocent. The author will try to prove that the above is a reasonable simile, and to show the hopelessness of the fracture method. What is good for the pig must be equally good for the casting, so far as that is concerned. Indeed, the casting is more often produced under known cooling conditions than is the pig, and the proof of the pig is in the casting. Take, therefore, the new Lanz "pearlitic" cast iron which we have heard so much about lately. Could any fracture-diviner point out the pearlitic test bars if he were given a thousand to select from? Analysis and the microscope could do so with certainty.

An iron may contain unbalanced sulphur. Can that be detected by fracture-gazing? Certain Diesel cylinder liners came to a most disastrous ending through that very cause, the failure being a mystery to everyone concerned until the unbalanced sulphur and its effects were discovered.

Again, suppose you desire to make iron containing a certain amount of silicon. It would be risky to guarantee success by sheer fracture-mixing. Or suppose the casting will be rejected if the phosphorus is lower than 0.4 or higher than 0.5 per cent. On the fracture myth, it would be a case of speedy bankruptcy.

Imagine again that you need high-manganese pig-iron. Can you tell if you are getting your money's worth by looking at it? Many of the irons advertised as having high manganese have nothing of the kind, when it comes to investigation of many consignments. They have *sometimes*. The makers guarantee nothing, so it is obvious that their fracture-diviner and that one in the foundry play a game which neither can win or lose. "We guarantee nothing" is the slogan. "We may say that our iron contains so much manganese, but we take no responsibility whatsoever if it does not."

Consider the question of sulphur. "Most important," says every foundryman. Yet his pig may contain, say, 0.040, 0.080, or 0.120 per cent.,

* Paper read at a meeting of the Institute of British Foundrymen (Scottish Branch), held in Glasgow, Mr. J. Affleck presiding.

and he will be none the wiser and his fracture-gazing will tell him nothing about it. Which means to say that the same pig-iron may contain twice as much, or three times as much, sulphur, and the foundryman cannot detect it. Do not let anyone think these are imaginary figures; they are the rule, not the exception.

In this Note it seems hardly worth while touching upon carbon. This is the most important element of all. It matters above all other things. The pig-iron people, many of them, do not mention it. Those who do, behave like Jerome's fisherman, and make things look prosperous before they start to exist. Hence, if the iron people insist that the carbon content is 3.0 per cent., then the foundryman may safely tack on another 0.5 per cent. If he complains about their generosity in the matter of carbon, and points out that they led him to expect less, he will receive a letter of mild surprise suggesting that he might do a re-analysis; also that he might keep in mind the fact that their figures were never said to be anything other than approximate.

The above remarks, and all these remarks, apply to ordinary common-or-garden pig-iron, and not to special irons.

Thus it has been shown the fracture-diviner is powerless to control either the silicon or phosphorus, or sulphur, or manganese, or carbon. When special cast-iron is required, it is necessary to control all these, and many other things as well, at one and the same time, and time after time.

Some people cherish fracture-gazing as though it were a national asset; to speak against it is to insult the household gods, the penates of the foundryman's home. That kind of attitude is encouraged by many sellers of pig-iron—yet it is to the detriment of British iron, British castings, and national progress. The Germans are patenting and marketing processes of which the sole foundation is the control and understanding of composition, whilst we, as a nation, are arguing about the merits or demerits of fracture-divining as if it were an intelligent and practical means of controlling the iron foundries of the country and of selling pig-iron.

Cast iron is sensitive, to a remarkable degree, to the slightest increase or decrease of any of its elements or compounds. Take two irons with similar amounts of carbon, silicon, phosphorus, sulphur and manganese, but one having a little more graphite than the other, and, consequently, a little less combined carbon. These small differences, absurd to the inexperienced, will affect the whole iron. For example, much has been attributed to graphite-size which is due to graphite-quantity.

Let those who do not believe the above statement attempt to pick out, under the microscope, samples of semi-steel from non-steel metal, all of which have been melted and cast under the same conditions and which have the same composition. It will be found that the graphite of semi-steel has no peculiar shape of its own. If an engineer orders semi-steel castings, he cannot prove whether he is getting them by looking at the shape of the graphite.

The amount of phosphorus is another matter of greater importance than many people perceive. High-phosphorus iron will the more readily be affected by, say, a minute amount of unbalanced sulphur than will low-phosphorus iron of otherwise similar composition. High-phosphorus iron can hold less pearlite than low-phosphorus metal, and the former will be able to contain cementite on a lesser total amount of combined carbon than the latter; similarly, the latter will be able to contain ferrite on a greater amount of combined carbon than the former.

So do the thousands of ramifications of this complex alloy lead, offering the most wonderful possibilities. Fracture-divining to-day is like fiddle-playing at a fire. When an iron has a half-dollar composition and a dollar ticket, the agent may ask you to look at the beautiful fracture, but it is not a wise thing to do. Beware also of faulty analysis and poor photography; they are more dangerous than fractures.

Perhaps as time passes the British foundryman will be educated up to demanding irons of standard composition—within stated limits—which state of affairs will be beneficial to the iron trade and the foundry trade of the nation. These talks are part of the education.

DISCUSSION.

The chairman (MR. AFFLECK) said they were all very grateful to Mr. Young for his very interesting address. He usually found that where a speaker made definite statements, there was a much better discussion than where one dealt with generalities, and Mr. Young, in the course of his Paper, had made some very definite statements.

MR. ABERNETHY said he had listened with mixed feelings to the Paper. Mr. Young had put before foundrymen a very fearsome picture, and he had made some wholesale assertions which, so far as Scotland was concerned, would not stand daylight. He (Mr. Abernethy) noticed that in one of the slides shown makers' analysis was given in which manganese appeared at 1.9. He did not think Scottish manufacturers advertised manganese at such a high figure. He had been an advocate of buying pig-iron to analysis, but at the same time he recognised, as Mr. Young had said, that a great number of founders had been used to working by the fracture, so makers were asked to supply iron to fracture and analysis. He might say that in the case of pig-iron from one cast out of the same furnace he had seen variations up to 1 per cent. of silicon in that cast, and it could be determined by the fracture—that was, by those who knew. Mr. Young's Paper had been more or less an advertisement for the chemists, and he could, to a certain extent, appreciate Mr. Young's position.

MR. YOUNG, in reply, said the foundry world had been wanting chemists for years, and the time had come when the engineering trade wanted good cast iron. But many makers were supplying cast iron just as their fathers had supplied it. He did not criticise the foundryman in his work. He thought he was a most skilful man, and he had great respect for the foundryman as a foundryman, but as a chemist, none. He might say, however, that a good chemist and a good foundryman working together were certain to turn out good work, and when they worked on these lines they would produce good cast iron. As a rule, castings were made so heavy that there was a considerable safety factor, and so the foundryman got through. The blast-furnaceman he did not criticise at all. He thought the time was coming when the foundryman would want to know whether the material he was being supplied with contained 1 or 3 per cent. silicon, and then he would get something near what he wanted. Referring to present methods, he said it was often the commercial man who came along and would sell them everything but guarantee nothing.

MR. THOMAS BELL remarked that it had been said that there was a class of casting wanted on the market for which the engineering trade was willing to pay any price if they could get the material. He had never met an engineer of that class. His experience was that the engineer ground the foundryman down as far as he possibly could. He would therefore like to know what the class of work was where they could get any price they liked to ask for.

MR. YOUNG, in reply, said the class of work to which reference had been made was that required for the construction of internal-combustion engines, and he could assure them that there were orders in the market for those who could produce the goods. The foundryman with a scientific staff behind him, who could produce goods of that kind, would get work. He quite agreed with what had been said that the foundry trade had been almost ruined by engineers endeavouring to cut prices, and now it was difficult to have a good supply of skilled labour. If they wanted a first-class foundryman to-day, they would probably find that he was about forty or forty-five years of age. They could not get young men to go in for the work because the trade had been almost spoiled. He thought that if there was any way to raise the status of the foundry, it was well worth trying.

On the motion of the chairman, Mr. Young was given a vote of thanks.

Institute of British Foundrymen.

Annual Dinner of the London Branch.

About sixty members and visitors attended the annual dinner of the London Branch of the Institute of British Foundrymen, which was held at the Engineers' Club, Coventry Street, Piccadilly, W., on Friday, December 19. Mr. V. C. Faulkner (the Branch-President) was in the chair, and was supported by Mr. R. O. Patterson (President of the Institute), Mr. J. G. Pearce (Director and Secretary of the British Cast Iron Research Association), Col. W. F. Cheesewright, D.S.O., Mr. Wesley Lambert (Past Branch-President), Dr. J. L. Haughton (Chairman of the London Local Section of the Institute of Metals), Mr. A. H. Mundey (Secretary of the London Local Section of the Institute of Metals), Mr. Gerald Bagshawe, and many others closely associated with the foundryman's art.

THE CHAIRMAN announced the receipt of telegrams expressing good wishes from Mr. H. G. Sommerfield (Hon. Secretary of the Branch), who, unfortunately, was still seriously ill, and who had had to take to his bed after his recent return from the South of France, and from Mr. Oliver Stubbs, the immediate Past-President of the Institute of British Foundrymen.

The toast of "The King" having been duly honoured,

COLONEL W. F. CHEESEWRIGHT, D.S.O., proposed, in his characteristic manner, "The Guests." There were, he said, a great number of guests present, and he was perfectly certain that functions of this sort would fall very flat indeed if the members of the Branch had not the pleasure of welcoming their guests. Referring to a number of the guests personally, he mentioned the name of Mr. Barker (Foundry Manager, Messrs. Harland & Wolff, Limited), to whom he extended a very hearty welcome. There was also present Mr. Martin Hall (of the Bean Motor Company). The next was his old friend, Mr. Bridges, whose name had been so prominently before the engineering public for so many years past, and the longer it was before the engineering public the more was it respected and renowned. Then there were Mr. Mundey (of Fry's Metal Company) and Mr. W. O'Keefe (of the Adaptable Machine Moulding Company of Birmingham). Finally, there was Mr. Gerald Bagshawe, who would respond to the toast. Some of them had a great deal to thank Mr. Bagshawe for. For instance, the members of the Branch had paid a very delightful visit to his works in May last. Mr. Bagshawe had been talking about his works, and it was obvious that a very high standard of efficiency was maintained there. In conclusion, Col. Cheesewright said it was a very great pleasure to him to be given so important a toast as that of "Our Guests," and in the name of the President and Council of the London Branch he extended to them all a very hearty welcome.

Labour Insufficiently Recognised.

MR. GERALD BAGSHAWE, responding, said he did not know whether the members of the Institute of British Foundrymen realised the influence they had on the trade as a whole, and on the people who bought the things they made. Their influence, of course, extended both to the material side and the labour side of the foundry manufacturing problem. They had still to arrive at the time when they could buy pig-iron of a guaranteed analysis. That time must come, however, and it was only through institutions of this nature that such results could be attained. Then there was the labour side. The labour in the foundry was one of the hardest branches of labour, and it was one of the most difficult ways of earning a living that a man could choose in this country. It was not a mode of earning a living which was likely to be a popular one, unless they made it a popular one. A man working in other branches of the engineering business, such as the machine shop or the pattern shop, saw almost immediately after the work was done whether it was right or wrong. The foundryman, however, had to take all the risk. He might have to wait a long time—perhaps days, or weeks, or months—before he knew whether the work was right. He could not look inside the mould and see what was going on there, and yet there were men who were sportsmen enough to make that their life-work. In these days the men were better educated, and they knew enough about the foundry industry not to take on the work unless they were sportsmen. It remained entirely with the managers, superintendents and owners of foundries in this country to bring the English moulder up to the same level. It could be done. We in this country had the most willing men in the world, and he felt that the Institute of British Foundrymen had it in its power to help to improve the situation.

In most other branches of the engineering industry there was a good deal known about the cost of the work, but there was very little known about the cost of the work in foundries in this country, except the information which was known by individual members of various firms who had developed it to a fine art. The general information on foundry costing was very, very limited, and they could not make a success of foundry work unless they knew definitely what their costs were. That raised another question, all part of the cost problem, which was one of the things that the Institute could deal with, and that was whether the basis for selling castings should not be reduced gradually to a basis of selling by the piece instead of by weight. (Hear, hear.) They had to get the draughtsmen to realise that the foundry existed. It was not an old hole in the corner that would make anything the draughtsmen liked to put on to paper. In conclusion, he said he regarded it as a great compliment that he had been asked to respond to the toast, and he could say, for himself and his fellow-guests, that they were having a very good time, that they were thoroughly enjoying themselves, and would like to come again.

The next toast was that of "The Institute of British Foundrymen."

The CHAIRMAN announced that the toast was to have been proposed by Mr. E. J. Fox (Managing Director of the Stanton Ironworks), but he had wired that he was ill and unable to travel. The Chairman expressed regret at Mr. Fox's illness, and the hope that he would speedily recover. They had a very excellent substitute, he said, in Mr. J. G. Pearce, who was appointed some time ago to the post of Director of the British Cast Iron Research Association, and he was sure that Mr. Pearce would do more than justice to the toast.

The Institute.

MR. J. G. PEARCE (Director, British Cast Iron Research Association) then proposed the toast. It was sometimes remarked, he said, that the foundryman was conservative, prejudiced and opposed to change, but he defied any craft in the United Kingdom to exhibit some of the progressive features which distinguished the foundry craft and the Institute of British Foundrymen. He defied any craft in the United Kingdom, for example, to produce a technical and trade journal so live and enterprising as THE FOUNDRY TRADE JOURNAL, which was edited so ably by their esteemed Branch President. He knew of no trade so admirably served as the iron founding industry in this particular connection, and nobody who had watched its progress for the last five years could fail to have been impressed by the enormous improvement which had taken place and by the admirable service which it gave to the industry as a whole. He also defied any craft in the United Kingdom to produce an Institute so enterprising and so good as the Institute of British Foundrymen. It combined in one body the operatives, the scientific men, the managing directors, and everybody concerned in the industry. There were the moulders and core-makers, metallurgists and chemists, managing directors, foundry managers

and foremen. He did not know of any Institute with such a live organisation of local branches, where local pride was so strong as in this great Institute. He did not know anybody which was prepared to arrange meetings at such awkward and inconvenient hours—(laughter)—in order that men might meet together and discuss the technical and practical problems of the craft, so as to ensure the minimum of interference with the ordinary business of those men.

Continuing, Mr. Pearce expressed regret at the illness of the esteemed Secretary of the Institute, Mr. Hollinworth. Coupling with the toast the name of Mr. R. O. Patterson, the President of the Institute, he said those who knew and admired Mr. Patterson, however, felt that it was a very great privilege for the Institute to have him as president. He was a man who, being at the head of a large and progressive foundry, knew the job from top to bottom, and he represented all that was best in the foundry craft of this country. It was a particular satisfaction to know, too, that, in addition to being President of the Institute, he was a member of the Council and of a number of committees of the British Cast Iron Research Association. The progressive spirit which came out in the one direction manifested itself in the other. The Institute had made very remarkable progress in the last few years, and it was in many ways unique. The industry was so complex that it needed all the efforts of every grade of man in it, and in no Institute were these grades so happily and amicably combined as in the I.B.F.

Pig-iron Must be Sold to Analysis.

MR. R. O. PATTERSON (President of the Institute) responded. He had come to the dinner, he said, feeling pessimistic. The enormous amount of work still to be done by the Institute sometimes more or less got on his nerves, but, thanks to Mr. Pearce, and his eulogistic remarks, he had put away from his mind what had to be done and had looked back a little and reviewed what had been done. It must be admitted that the work done by the Institute was remarkable. But there were considerable difficulties before the Institute yet. He believed that last year, in that very room, a blast furnace owner had stated that selling to analysis was, more or less, the devil: he had said he was not going to do it. Well, said Mr. Patterson, how were they to progress, as foundrymen, if they knew nothing about the article they were dealing with. They must have it, and had got to push for it, and undoubtedly, if every member of the Institute demanded his iron to analysis, he would get it. When all was said and done, they were the consumers, and paid the piper for the tune they wanted. The old foundryman was as sensitive as a man could possibly be, and did not take kindly to innovations. He had no use for a laboratory, and wanted to go on with the old mixtures—a certain percentage of hematite, a bit of Scotch, a bit of No. 3 to toughen it and a bit of No. 4 to harden it, and all that sort of thing, and by the time he had the mixture finished the poor mixture did not know where it was. (Laughter.) Therefore, the metallurgist was wanted badly, but he had to tread lightly in the foundry until there was a new generation of foundry operatives. The new men were coming along in good style, he must admit, and he had no doubt that in a very few years the industry would get along better than at present. Reference had been made to the American and the English workmen. He believed that any employer in any branch of the engineering industry to-day would admit that his men were too badly paid. There was no getting away from it. The English foundry worker was worse off than he was before the war, though the position was bad enough then. We in this country undoubtedly had the very best workmen in the world, and he would back them against the workmen of any country. The Institute of British Foundrymen had to lift up the industry, to make progress, and in every direction to improve the lot of the worker. They wanted to pay the worker more money, to lift him up above the average level, and it was up to them to do it. The British Cast Iron Research Association was established, and was well on its feet. Unfortunately, the industry had been through some very severe times during the last few years, and undoubtedly the Research Association had not been supported as well as it ought to have been. It was not that they could blame the iron founders, because they had not had the money adequately to support it, the reason being, of course, as was well known, that they were not getting an adequate price for their product. Another matter to which Mr. Patterson referred was the exhibition which was being organised by Mr. F. W. Bridges (who was present at the dinner), and which is to be held in London in 1926. The exhibition had the official blessing of the Institute, which was given by the Council at the last general meeting. What the Council would like to see would be an exhibition possibly every two or three years, but they wanted that exhibition to be held where the Convention was being held. That was very desirable, because many of the members simply could not afford either the time or money to go to two places, and they could be sure that the members would go to the Convention. If the exhibition were held at the same place as the Convention, the members would get there, but otherwise they would not. Exhibitions were very desirable things. They had seen what had been done in Birmingham, and that was an education to all of them. In conclusion, Mr. Patterson expressed the thanks of the Institution for the very kind manner in which the toast had been received.

Kindred Associations.

MR. WESLEY LAMBERT (past Branch President), in a neat and witty speech, proposed the toast of "Kindred Associations." He had noted, he said, quite a number of institutions, associations and societies which might be regarded as kindred bodies. They were all very pleased to see the number of planets and stars in the heavens; they formed a fitting complement to the sun, and in like manner all these kindred associations were complementary to the Institute of British Foundrymen. In this analogy, of course, the Institution of British Foundrymen claimed to be the sun, and, after what they had heard from some of the speakers that evening, he did not think it would be too presumptuous for him to do so. He would remind all the kindred associations that, were it not for the practice of the art of founding, metals, as such, would be useless; they would have no value. They had to be founded in some way or other, and if they were useless this toast would be redundant. As Dr. Haughton was present representing the Institute of Metals, he supposed they had better give Dr. Haughton the moon, and as a sort of make-weight they might give him Mars for the London Local Section. He did not wish to suggest for one moment that, by likening the Institute of Metals to the moon, the Foundrymen regarded the Institute of Metals as being a dead body. (Laughter.) It was quite true that the majority of its emanations seemed to favour somewhat the occult, but occasionally a paper of foundry interest filtered through, and he was alive to the fact that the Institute of Metals knew that such a mundane industry as metal founding was still going on. The Institute of British Foundrymen was very much indebted to the kindred institutions and associations, especially the research associations, such as the Cast Iron Research Association and the Non-Ferrous Research Association, for the information obtained from them. Knowledge was power, and it certainly was power in the foundry. Those in the foundry wanted as much knowledge as they could possibly get.

DR. J. L. HAUGHTON (Chairman, London Local Section of the Institute of Metals) responded. Commenting jocularly on Mr. Lambert's analogy, he said he was perfectly prepared to admit that the Institution of British Foundrymen could be represented by the sun, but he would have preferred Mr. Lambert to have suggested that the kindred associations were other suns in the cluster. He believed that in the clusters of stars most of the stars were of about the same magnitude. Mr. Lambert had added to his unkindness by giving to the Institute of Metals not only a planet of the sun, but a planet of a planet of the sun. He had given it an extraordinarily inferior position: he had also given it Mars as a sort of make-weight, but if he had suggested that the Institute

of Metals was Jupiter, or even this earth, he (Dr. Haughton) would not have minded, as Jupiter was one of the finest and biggest of the planets. Then Mr. Lambert had tried to tone down his bitterness by suggesting that the Institute of Metals was not quite dead, but he seemed rather to think it was, all the same. In the old Norse mythology, continued Dr. Haughton, they used to talk about a tree which represented something very important; the roots of the tree were right down below the ground, the trunk was in the world, and the branches of it were up above in the heavens. The kindred associations could be divided into those three parts of a tree; the people who were connected with the getting of the materials out of the ground represented the roots of the tree, those who made use of the materials and made them into useful things, such as the members of the Institute of British Foundrymen, represented the trunk, and then there were the research people, who were, of course, the people right up in the heavens. (Laughter.)

Mr. A. H. MUNDEY (Director, Messrs. Fry's Metal Foundry) proposed the final toast, that of "The London Branch." This toast, he said, was really and truly the toast of their noble selves, but he would ask them all to drink it, because it was to include their Branch President. The London Branch of the Institute of British Foundrymen had set a splendid example of co-operation to many other of the sections, particularly the sections of other institutions. The one thing that was needed in all industries was this spirit of co-operation, and foundrymen particularly needed the co-operation of those people who contributed definitely to the well-being of their work. He supposed that the first person whose co-operation the foundryman needed was the designer, who designed the article to be cast, because he was the man who made the task very difficult or comparatively easy. Next, he needed the co-operation of the metallurgist, who was going to provide him with the right kind of material. Next, he needed the co-operation of his workmen, the craftsmen, and this was most important of all. Not enough, by any means, had been said about the craftsmen; it was upon the craftsmen, and the craftsmen alone, that we had finally to depend. Ingenious pieces of apparatus were made, whereby the craftsman's skill appeared to disappear for a moment, but it was not so, and they all knew it. It was his (Mr. Mundey's) lot to try to co-ordinate those two or three factors he had mentioned; but there was a final factor, which was an important one. They wanted to get people to buy the stuff when they had made it, and thus they must get the co-operation of the commercial man. However much they might despise the commercial man, and say that it was all very well for him to sit in an armchair and order things, they must get his co-operation, and that of the salesman. In a tribute to the chairman, Mr. Faulkner, he said he was certain that they had in him one of the best men they could possibly have. He had been an inspiring force to the London Branch—because he was certain that Mr. Faulkner's entry into the councils of the Branch had almost synchronised with its re-awakening. Not only was he doing good work himself, but he was making other people do it, and was making it known.

The toast was honoured with enthusiasm, the company singing "For he's a jolly good fellow"

The Work of the London Branch.

THE CHAIRMAN, responding, said it was difficult for him to collect his thoughts adequately to respond to the toast so ably proposed by Mr. Mundey. For his own part, anything he could do for the Branch, or anything he had done, he was only too pleased to do. It was always a work of pleasure, because he was so cordially supported by the Council, and his only regret was that the general body of the members of the Branch did not give the same support as was given by the members of the Council, who turned up, something like 80 per cent. of full force, at every Council meeting, whereas at the ordinary meetings the attendance was only something like 20 or 25 per cent. maximum. It must be remembered, however, that the Branch was different from any other Branch of the Institute: it had its membership as widely spread as from Middlesbrough to Southampton, and it was impossible for all those gentlemen who cared to associate themselves with the London Branch to turn up regularly. In fact, their numbers were not really justified, because there were members as far away as India, Australia and South Africa who were also London Branch members. Literature was veering round strongly to an appreciation of the foundryman. In a recent work on "The Economics of Iron and Steel" he was pleased to note that the foundry took up a very considerable proportion of the space. The book was particularly eulogistic in regard to the Institute of British Foundrymen, which had done so much to make progress in foundry work possible; the date of the improvement in foundry practice, from a metallurgical and a national point of view, dated from the inception of the Institute. The most important factor in the foundry world to-day was costing. If we in this country could but follow the lead of America, France, Belgium and Germany, we should form a system of costing which would be on a national basis, and prevent the latest foreman who had set up in business fixing the prices for the trade, as he did at the present moment. There was need for a definite, systematic method of costing, which was based on common sense and not on guess work; it was the guess work which was ruining the industry, and the sooner foundrymen realised it and evolved a national unified system of costing to which the whole of the foundries could agree, the sooner should we make progress. In conclusion, Mr. Faulkner expressed his cordial thanks for the manner in which the toast had been proposed and received. He hoped the Branch would continue to make progress, and was confident that it would in the future under the Presidencies of Mr. R. J. Shaw and Mr. G. C. Pierce.

This concluded the speeches. An excellent musical programme—arranged by Mr. Arthur Ayres—was rendered during the evening, which was appreciated by all present.

BIRMINGHAM BRANCH.

The Birmingham Branch of the Institute of British Foundrymen held a propaganda meeting at Wolverhampton on December 18, when Mr. G. E. Dicks, of Birmingham, gave a popular lecture on pattern making. There were a number of interesting lantern slides. Mr. Thomas Vickers, Branch-President, occupied the chair, and there was a large attendance.

The President explained the objects and work of the Institute, emphasising that it did not interfere with any labour or commercial aims, being purely educational.

The lecturer, before proceeding to a general survey of his subject, referred to the necessity of co-operation between the drawing office, the pattern shop, and the foundry. Only in recent years, he said, had these departments recognised the many advantages to be gained by mutual exchange of views and knowledge of each other's trade. This working together was the best way to increase output and produce satisfactory castings. Much as he appreciated the difficulties of a draughtsman, he was not in such close touch with the foundry as the pattern maker, and many difficulties could be overcome by consultation. He considered all pattern makers should have a technical knowledge of machine drawing and construction, together with some practical training in foundry work. An appeal should be made to the youths and younger men to grasp the many advantages to be gained by attending night classes. The knowledge thus obtained, perhaps with a little sacrifice, would be amply repaid later by the men having the satisfaction of being "on the top of their job." The existing apathy was deplorable; let them hope it was only a passing phase. At the Foundry Trades' Exhibition last June the number of competitors in the pattern-making sections was very disappointing, only between 40 and 50 competing, although the competition was open to all England. Nor was there much exceptional merit displayed; in fact, the premier prize was won by a youth of twenty.

A brief discussion followed the reading of the Paper.

Trade Talk.

RICHARD THOMAS & COMPANY, LIMITED, have decided to reopen their Lydney and Lydbrook mills.

F. A. WELLING & COMPANY, LIMITED, iron and steel merchants and agents, 88, Fenchurch Street, London, E.C.3, have removed to 10, Lime Street, E.C.3.

WILLIAM CORBETT & COMPANY, iron, metal and tinplate merchants, 74, Summer Row, Birmingham, have removed to 63, Great Charles Street, Birmingham.

THE KOPPEL INDUSTRIAL CAR AND EQUIPMENT COMPANY have removed from 53, New Broad Street, E.C.2, to Coventry House, South Place, Moorgate, E.C.2.

MORLEYS, iron, steel and metal merchants, 7-8, Temple Chambers, Broad Street, Birmingham, have removed to Alston Buildings, Spiceal Street, Birmingham.

EVERSHED & VIGNOLES, LIMITED, announce that reductions in prices varying up to 25 per cent. on standard models of the Ducter low resistance testing set equipments took effect on January 1.

VIVIAN & SONS have decided to have a large portion of the plant at the Hafod White Rock and Silver and Lead Works sold by auction. The smelting department at the works has been closed for some time.

WEST'S GAS IMPROVEMENT COMPANY, LIMITED, of Miles Platting, have secured for £120,000 the contract for carbonising plant with 112 retorts, and a capacity of 7,000,000 cub. ft. of gas a day, for the Gas Light & Coke Company, in connection with the extension of the Nine Elms works of the company.

FOLLOWING A VOTE in the City Council on December 3, the Manchester Corporation Tramways Committee have reversed a former decision to place a contract for rails for special track work with the United States Steel Products Company, and have given the work to Hadfields, Limited, Sheffield. The difference in price was only £85.

SIEMENS AND ENGLISH ELECTRIC LAMP COMPANY, LIMITED, 38-39, Upper Thames Street, London, E.C.4, have an order for the supply of train lighting lamps for the Great Eastern section of the London & North-Eastern Railway Company. They have also secured a contract from the Booth Steamship Company for the supply of electric lamps for the whole of 1925.

THE GENERAL ELECTRIC COMPANY, LIMITED, Magnet House, Kingsway, London, W.C.2, have secured the following contracts:—India Office: Quantity of Edison primary cells and renewals, also track circuit relays, polarised relays and signal lever contact makers for an Indian State Railway. Great Western Railway and the London & North-Eastern Railway (Southern Area): Twelve months' supply of track relays and track resistance units.

AN EXAMPLE of smart work was carried out at the brass foundry at Walker Gate of Henry Watson & Sons. Two large manganese bronze propeller blades for an urgent repair job were cast and delivered to machine shop—the first in five days, and the second one in seven days. At the same time an order was executed for two 29 ft. shaft liners in gunmetal for the Cunarder "Mauretania." The first of these was cast, turned and despatched in six days, the third one following a couple of days later.

IN CONNECTION with the announcement that Vickers, Limited, had associated itself with the Commonwealth Steel Products, the amount payable by the Vickers firm is £50,000. In announcing the terms of the amalgamation at the annual meeting of the Products Company, the chairman said that the reorganised company would be known as Vickers Commonwealth Steel Products. He was pleased to announce that Vickers had definitely thrown in its lot and amalgamated with the Commonwealth Company. Extensions would take place in order to enable the company to undertake in Australia the manufacture of wheels, tyres, locomotive steel castings, and any work of a similar nature.

GUEST, KEEN & NETTLEFOLDS, LIMITED, in conjunction with T. Piggott & Company, have completed arrangements for the establishment of a steel pipe manufacturing works at East Moors, in the vicinity of the Cardiff-Dowlais Works, in premises which were originally intended to be an extension of the steelworks. Machinery and plant to equip the new works are being installed, and it is anticipated that in the course of the next few weeks employment will be given to 100 men. Guest, Keen & Nettlefolds will supply the steel plates to be used in the manufacture of the pipes, so that the entire production will take place in Cardiff. The first contract to be executed by the new works will be on behalf of the Cardiff Corporation. At a meeting of the Waterworks Committee of the Corporation on Monday the tender which Guest, Keen & Nettlefolds had submitted for the supply of steel concrete-lined pipes for the second pipe-line from Taff Fawr was accepted. The price tendered for the contract was £100,561.

Obituary.

MR. P. SHACKLETON, who was for about 50 years the manager of the Saunder Bank Ironworks, Burnley, died recently at the age of 77 years.

MR. W. H. JOHNSON died at his residence, 173, City Road, Edgbaston. Mr. Johnson was the general secretary of the National Brass and Metal Mechanics.

MR. ARTHUR MARTIN, who was the proprietor of foundries at Revin, Brussels, Huy and St. Hubert, and was well known in British foundry circles, died recently.

MR. H. HEMINGWAY, who recently died at his residence, 2, Mayfield Avenue, Halifax, was head of the firm of Henry Hemingway & Company, brass founders and finishers, Boulevard Works, Halifax. He was 67 years of age.

Contracts Open.

Baildon, January 20.—150 tons or thereabouts of 8-in., 7-in., 6-in., 5-in. and 4-in. spigot and socket cast-iron water main to the British standard specification for cast-iron water pipes, Class C, together with the necessary specials, etc., for the Baildon U.D.C. Mr. C. E. Bean, waterworks engineer, Council Offices, Baildon. (Fee, £2 2s., returnable.)

Cape Town, June 3.—About 33 miles 33-in. diameter steel pipes and specials cement-lined, for the Steenbras Waterworks at Cape Town. The office of the City Engineer (Waterworks Branch), Cape Town, or from the London agents of the Council, Messrs. Davis & Soper, Limited, 54, St. Mary Axe, London, E.C.3. (Fee, £5 5s., returnable.)

Leeds, January 12.—One stationary stonebreaking, elevating and screening plant, for the Corporation. The Highways and Permanent Way Engineer, 1, Swinegate, Leeds.

London, S.E., January 19.—(*a*) About 3,700 tons of standard steel girder tramway track rails, lipless track rails and fishbolts, and, alternatively, of about 4,700 tons of such rails and bolts; (*b*) about 700 tons of conductor tee rails for the London County Council. The Chief Engineer of the Council, at the Old County Hall, Spring Gardens, S.W.1. (Fee £2, returnable.)

Manchester, January 13.—Materials, for the Tramways Committee. Mr. H. Mattinson, general manager and chief engineer, Corporation Tramways, 55, Piccadilly, Manchester.

Company News.

Allen-Liversidge, Limited.—Interim dividend, 10 per cent. per annum, less tax.

United Strip & Bar Mills, Limited.—Profit, £12,588; debit balance brought in, £42,698.

Petters, Limited.—Dividend, 7½ per cent. per annum on preference shares for six months.

Gibbons (Dudley), Limited.—Interim dividend, 3½ per cent., free of tax, on ordinary shares.

Siemens Brothers & Company, Limited.—Dividend on 10 per cent. cumulative preference shares for current half-year.

Marley Hill Chemical Company, Limited.—Final dividend, 3 per cent., less tax, making 7 per cent., less tax, for year.

Edward Wood & Company, Limited.—Dividend, 5 per cent. per annum on preference shares for half-year; no interim dividend on ordinary.

Redpath, Brown & Company, Limited.—Loss for sixteen months, £35,767; carried forward, £84,771; balance, £49,004; taxation and contingencies, £17,221; available, £31,782; dividend 6 per cent. on preference shares, less tax, £11,180; carried forward, £20,601.

A. M. Dickie & Sons, Limited.—Capital £5,000 in £1 shares. Engineers. Directors: A. M. Dickie, P. S. Dickie, A. Dickie, jun., T. W. Dickie and J. Dickie. Subscribers: A. Draycott, 1, Crosshall Street, Liverpool; A. L. Corlett, 1, Crosshall Street, Liverpool.

Appleby & Company (Sheffield), Limited.—Capital £500 in £1 shares, to acquire the business of iron and steel and file manufacturers and merchants carried on by J. E. Appleby, C. Appleby and S. Gladwin at 218, Rockingham Street, Sheffield, as Appleby & Company. Director: J. E. Appleby.

Walter Somers & Company, Limited.—Loss, £11,098 in year 1923-24; depreciation, £26,629; brought forward, £103,482; preference dividend paid, £214; total debit balance, £137,274. Report for 1922-23: Loss, £40,919; debenture interest, £11,060; depreciation, £26,607; brought forward, £62,456; preference dividend paid, £107; debit balance at March, 1923, £103,482.

XUM

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The reopening of the Cleveland iron markets after the holidays has so far resulted in very little additional business, the majority of consumers having already bought to cover their requirements over the current month. Inquiries for No. 3 iron are, however, coming forward rather more freely extending over the first quarter, and the outlook by all accounts is regarded with much more confidence than was generally the case during the year just ended. In this week's market prices have been nominally unaltered, but any substantial prompt parcels could be done on favourable terms. This is, of course, a temporary phase, and it is probable that values will again harden as soon as the market settles down. Quotations stand nominally as follow:—No. 1, 86s.; No. 3 G.M.B., 81s.; No. 4 foundry, 80s. 6d.; and No. 4 forge, 80s. per ton.

Deliveries of hematite having been practically suspended over the past fortnight, some slight accumulations of stocks have been inevitable, and makers at the moment are making concessions in prices to get rid of the surplus on hand. East Coast mixed numbers are nominally 88s. per ton, but can be obtained for a trifle below this figure. No. 1 is at a premium of 6d. per ton. The outlook in the Western area is, on the whole, distinctly hopeful, and there is every expectation that the necessity to light two additional furnaces will arise in the near future. Prices so far are unchanged, Bessemer mixed numbers being quoted at 99s. per ton delivered at Glasgow, 102s. 6d. per ton delivered at Sheffield, and 107s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—At Manchester this week a fairly cheerful tone prevailed in the market for foundry iron, and sellers were offering Derbyshire iron for March deliverey at 90s. per ton, while for Northamptonshire iron 89s., or even 88s. 6d., delivered local, is a possible price, but without very much demand for it. As a rule, founders prefer the Derbyshire irons even at 1s. per ton more. The Lincolnshire brands remain comparatively scarce here, and those who will use them must expect to pay rather more than for Derbyshire. Scotch No. 3 is quoted at the old price, viz., 107s. 6d. per ton.

THE MIDLANDS.—At the Birmingham quarterly meeting this week there was an increased volume of inquiries for foundry iron for deliveries over the first quarter, with growing confidence in better times ahead. Prices meanwhile ruled steady, with quotations as follow:—Derbyshire No. 3 foundry, 82s. to 82s. 6d.; forge, 75s.; Staffordshire No. 3 foundry, 87s. 6d.; forge, 80s.; Northants No. 3 foundry, 76s. to 77s.; forge, 69s. to 71s.

SCOTLAND.—Only a limited number of consumers' works have resumed full operations this week, and consequently markets for foundry iron have been more or less inactive. In these conditions quotations are unchanged, makers still maintaining their price of 90s. per ton for No. 3, although merchants are prepared to accept a lower figure. The threatened reduction in pig-iron production has now become an actual fact, four furnaces having been recently blown out, making the number of furnaces operating in Scotland 28, or only a shade more than one-third of the normal number.

Finished Iron.

One of the things which makes one rather sceptical as to the prospects of extensive improvement in trade conditions is the complete failure of finished iron to show any signs of revival. Right up to the year-end makers experienced very great difficulty in keeping works running steadily, and in the aggregate many "turns" were missed. Of course, marked bars furnish an exception to this generalisation. Conditions affecting them are such that they enjoy a more or less steady market. The failure to expand to brighter sentiment is confined to crown and commoner irons. The demand for all these is about as much below the productive capacity of the district as it has been for so long, and so far there seems no immediate prospect of full and steady employment for the works that remain in operation, or that the inactive ones will be restarted. Nor will there be until there is less disparity between iron and steel prices, and iron ceases to be more or less a "luxury" material indispensable for a comparatively few special purchases, but easily dispensed with for the great majority of ordinary purposes. It is taking the people mainly responsible an unconscionably long time to recognise this and to act upon it.

Steel.

Optimism in a modified form will, perhaps, best express the general impression in the steel trade with regard to the prospects of the industry in 1925, this sentiment being doubtless encouraged by the announcements of the railway companies of extensions of permanent-way improvements and by enormous additions to rolling stock and electrical equipment. The market for semi-products, however, continues only moderately active, while possibly the most unsatisfactory feature of the position is the fact that it is due to internal conditions rather than to any new or intensified attack of foreign competitors.

Scrap.

Concurrent with the conditions outlined under the heading of "Pig-iron," business in the various markets for scrap metal may be described in synonymous terms. In Lancashire, however, cast scrap is firmer, and a higher range of prices is very confidently expected during the new year. Holders of the finer lots of heavy machinery cast scrap, say scrap from textile machinery, should not now quote below 90s. per ton, and for quite ordinary lots of metal 85s. is wanted. In the Scottish markets machinery cast-iron scrap is again quiet, foundries holding off temporarily, but the nominal price is around 90s. per ton and for ordinary 5s. per ton less—that is, for material in pieces not exceeding 1 cwt. and suitable for foundries. Steelworks cast-iron scrap in furnace sizes is around 85s. per ton, and for old cast-iron railway chairs about 90s. per ton.

Metals.

Copper.—Movements in standard metal since the resumption of business have developed additional strength, influenced by liberal support from large dealers and buoyant American reports, while some heavy sales are reported to have been effected by producers to domestic consumers for deliveries spread well over the next quarter and even further ahead. The American quotation has been advanced to 14¾c. per lb., and it is confidently expected that under their much-improved position producers will be encouraged to lift their terms further in the near future. Warrant prices on this side amid quite brisk dealings were raised to over £68 a ton for three months' delivery, and closed with a very firm undertone, in spite of some realisation. Current quotations:—*Cash*: Friday, £67 5s.; Monday, £67 17s. 6d.; Tuesday, £67 5s.; Wednesday, £67 5s.

Three months: Friday, £68 7s. 6d.; Monday, £69; Tuesday, £68 7s. 6d.; Wednesday, £68 7s. 6d.

Tin.—Values in this section of the metal market have been subject to some variations, due to speculative influences, but, on the whole, quotations may be reported as firm, with a steady upward movement. This view gains distinct encouragement from Eastern advices indicating a fairly definite clearing of the "pool" stocks in the East, as recently intimated by an official cabled announcement that up to December 18 only 587 tons were left thereof, after sales effected of 725 tons since November 24 last. Judging from the further heavy sales reported just before the holidays, it is assumed that the remnant above mentioned has been disposed of, so that the market has now only to reckon with current production. Apart from this consideration, the friends of tin have been largely influenced by optimistic anticipations as to the gradual renewed growth of American consumption. Current quotations:—*Cash*: Friday, £274 10s.; Monday, £277 10s.; Tuesday, £273 5s.; Wednesday, £274 10s.

Three months: Friday, £277 17s. 6d.; Monday, £281; Tuesday, £277 5s.; Wednesday, £278 10s.

Spelter.—The market for this metal continues strong, chiefly due to the somewhat uncertain outlook as regards future supplies. In the United States the firmer tone has continued, and the market is quotable at 7.50c. East St. Louis basis for Prime Western, for December to March. The strengthening has been due to a firmer attitude on the part of sellers rather than increased demand. Current quotations:—*Ordinary*: Friday, £38 12s. 6d.; Monday, £38 10s.; Tuesday, £38 7s. 6d.; Wednesday, £38 10s.

Lead.—Business in soft foreign pig continues to develop strength with recent sales at the new high record of £44 per ton, against £40 at the beginning of the month. The spread is round £2. There was a considerable business done in March and April deliveries. Supplies here are very well controlled, but there may be more movement from Australia when the new wheat begins to move.

The following are the weekly prices:—Current quotations:—*Soft foreign (prompt)*: Friday, £43 17s. 6d.; Monday, £44; Tuesday, £43 17s. 6d.; Wednesday, £43 2s. 6d.